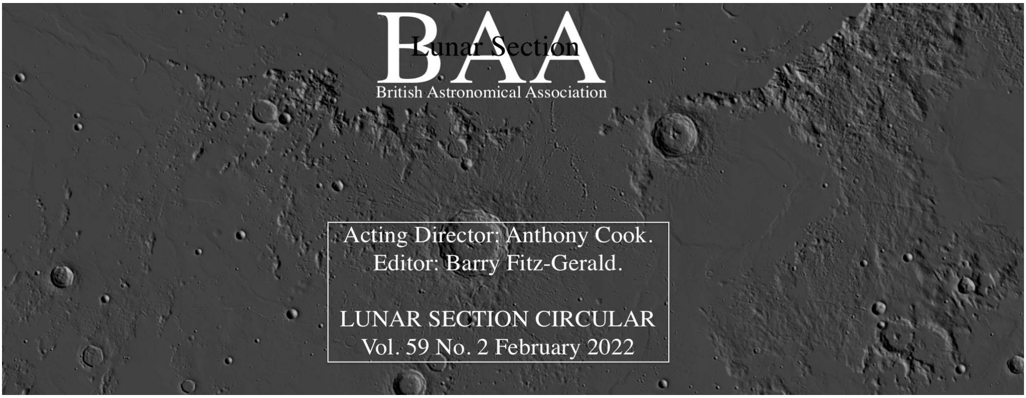

Editorial.

January from Mid Wales was amazing! According to my observing records it was possible to observe on 12 dates. This has been reflected in the wide variety of observations sent in by other members in the UK. We cover many different types of lunar geology this month as you can see by the images received.

Don't forget that we are not just looking at the Moon though. Tim Haymes sub-section is actively observing occultations, which can tell us for example whether stars are double or have angular diameters. Many of the imaging cameras used to produce the excellent images in the circular are capable of high frame rates, which makes them highly suited to this kind of work. So why not give occultations a go and see if you can help the research activities of Tim's group.

I am still adding additional repeat illumination targets onto the Lunar Schedule web site to reproduce the same lighting conditions for sketches from the BAA Lunar Section's The Moon publication from the 1960's.

Just a reminder, please send all observations to me, preferably before the 20th of each month, as this maximizes the chance of something being included in the circular.

Lastly do not forget to take a look at the Lunar Schedule web site https://users.aber.ac.uk/atc/lunar_schedule.htm to see what observing opportunities are coming up in February.

Tony.

Correspondence Received.

From: John Axtell:

The Lunar 200 List

I'm principally a visual observer, mostly deep sky but enjoy the Moon too, and am wading through the Lunar 100, just 11 left to find. I've also just made a start on the Lunar 101-200 list, but haven't found much about it online. Is anybody aware of something like a map of these objects that would make a handy guide to help plan a viewing session? I'd be grateful for any pointers to this list you might know about - I just find lists help me to structure sessions and look for things I'd otherwise gloss over..

From the Director: I was not aware of the Lunar 101-200 list until I received John's email, but traced it down to https://stargazerslounge.com/topic/97176-new-lunar-100-200-list/ - just in case anybody is interested.

From the Director: *Tim Haymes forwarded me on the following email from the Minor Planet Mailing List – Digest #503*

SpaceX Falcon 9 rocket body lunar impact prediction (far side)

2015-007B = NORAD 40391 is a SpaceX Falcon 9 rocket body launched in 2015. It has a good chance of impacting the Moon in March.

Hello all,

My thanks to everybody who sent in data for this object. It's just zipped around us at perigee, gone through the earth's shadow, and is now headed to low elongations, and will be effectively unobservable until early February. But the astrometry nicely confirms a lunar impact on the far side with a fairly exact location and time (12:22 UTC on 2022 March 4).

I've added something resembling an FAQ to

https://www.projectpluto.com/temp/dscovr.htm

and will doubtless be back requesting data sometime around 7 February.

From the Director: Although we won't be able to see the impact. As it is on the far side, no doubt people will be looking for the impact crater in past and future NASA LROC images.

Observations Received.

Observations have been received from the following: Paul Abel (UK), Leo Aerts (Belgium), Peter Anderson (Australia), John Axtell (UK), David Finnigan (UK), Valerio Fontani (Italy), Rik Hill (USA), Bill Leatherbarrow (UK), Rod Lyon (UK), Mark Radice (UK), Bob Stuart (UK), Aldo Tonon (Italy), and Alexander Vandenbohede (Belgium).

Apollo 12 landing site.

Image covering Fra Mauro, (Bottom Right), Reinhold (Top Left), and Lansberg (centre left), and the Apollo 12 landing site. Taken by Aldo Tonon on the date and UT given in the image.

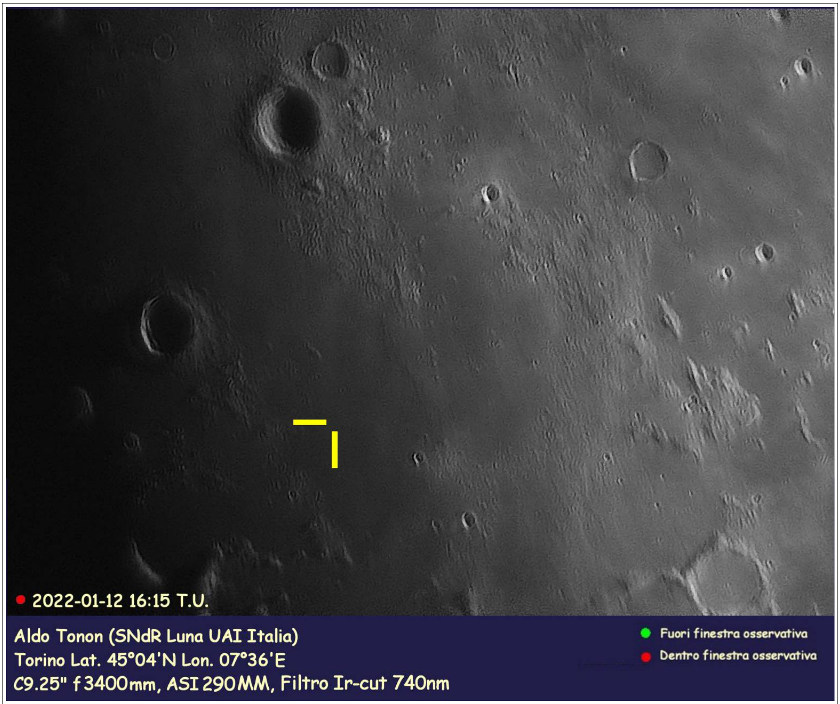

Figure 1. the Apollo 12 landing area – marked by yellow tick marks.

From the Director: When Apollo 12 astronauts, Alan Bean and Charles Conrad, landed on the Moon on 1969 Nov 19 UT 06:55 most astronomers were probably watching on TV. However, if they had been outside at the time, this is the exact view that they would have seen (ignoring libration), in terms of illumination. Apollo 12 was remarkable in that it was a pin-point landing, within about 200 metres on the Surveyor 3 robotic lander and you can see the camera that the astronauts brought back from Surveyor 3 in the National Air and Space Museum in Washington D.C. if you are ever in the area. Thanks to UAI observers Valerio Fontani and Aldo Tonon for attempting to image this area under these specific illumination conditions. Aldo's image is shown in Fig 1. NASA clearly were playing it safe landing here as the area is relatively flat. Only in the later Apollo missions did they start to land in riskier, but more scientifically interesting sites.

Copernicus.

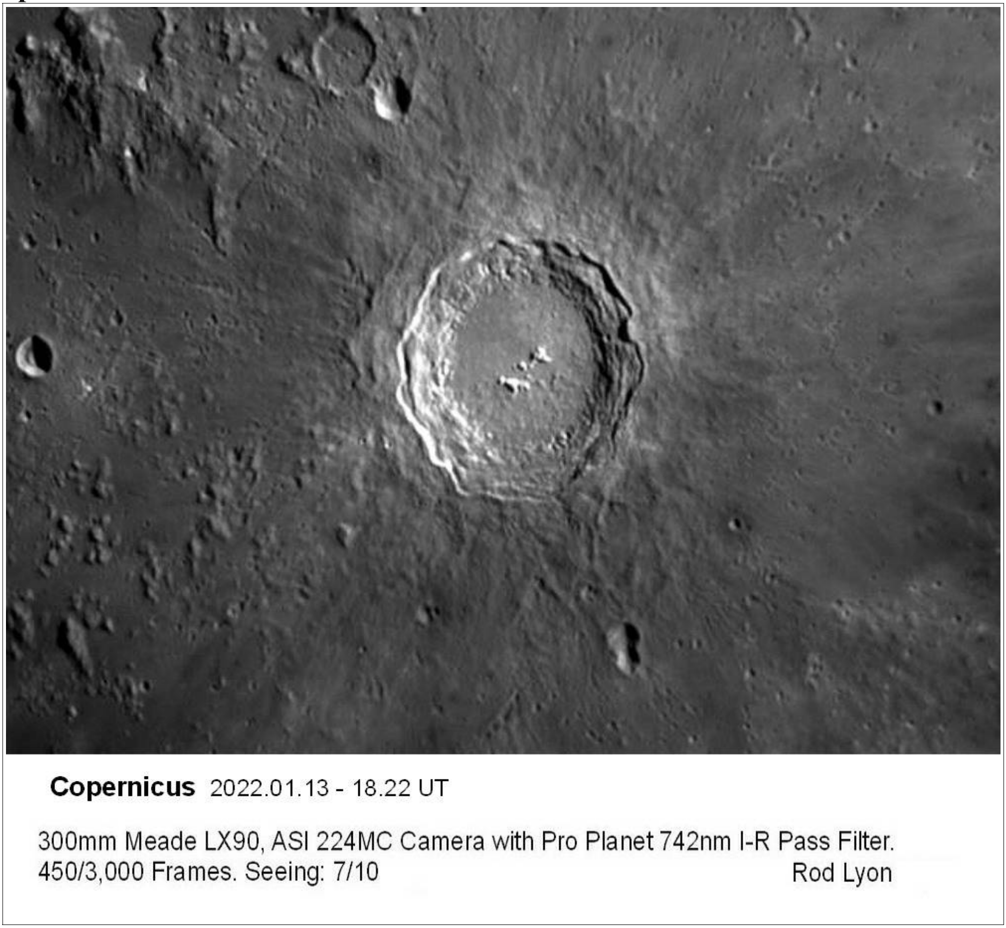

Figure 2. Copernicus as imaged by Rod Lyon. See image for date, UT etc. North is towards the top.

From the Director: Rod Lyon sent in eight images, and like those from Bill Leatherbarrow (see later in the circular) it was very difficult to choose. However, I picked this one of Copernicus as although it has relatively little shadow, it does display the ejecta blanket of this 83km diameter crater quite well. A few examples of bifurcation structure can be seen close to the outer rim, before ejecta patterns of secondary craters become more radial. The floor of Copernicus has not just one central peak but three in a line. External to Copernicus there are some dark halo craters.

Rod comments about the observing conditions: *"At long last - January 11th saw the first chance of imaging since November 23rd! During the late afternoon, it appeared that the incessant cloud cover was at last looking as though it was breaking up, but frequent trips outside during the early evening didn't produce the hoped for clear sky. Then at 9pm, I decided to look out for one last time and surprise, surprise - a crisp looking moon in a clear sky. I was at last in business!*

I then had 4 cloudless nights in a row, during which I managed some fairly satisfactory images. Although completely cloudless each night, the seeing wasn't particularly steady and there was a lot of moisture in the air - particularly on the second and third nights, insomuch so that on completion of the imaging session, the inside of the observatory was quite wet to the touch, and when I closed up, there were droplets of condensation dropping off the edge of the dome. Thanks to my dehumidifier, next morning the observatory was bone dry again.The turbulence at times was quite strong, but there were periods when things steadied up a bit."

West of the South Pole.

An image (Figure 3) of the lunar limb, west of the south pole, as captured by Mark Radice on 2022 Jan 17 UT21:50, using a C11 scope at f/20 (x2 Barlow) with an ASI 224MC camera operating through a 685 nm IR filter. Seeing conditions poor. North is towards the bottom and partly to the left.

From the Director: Mark says that he was amazed by the amount of detail that he could capture on the lunar limb, just a few hours before Full Moon. Cabeus crater is 98 km in diameter, and has a permanently shadowed interior on its western side (obviously not visible here), where temperatures fall as low as -173 C.

It was here in 2009 that NASA's LCROSS mission struck the Moon to see if any of the debris thrown up contained frozen volatiles – they were not disappointed by the results that suggested about 6% by mass of the ejecta was water vapour, ice and other volatiles.

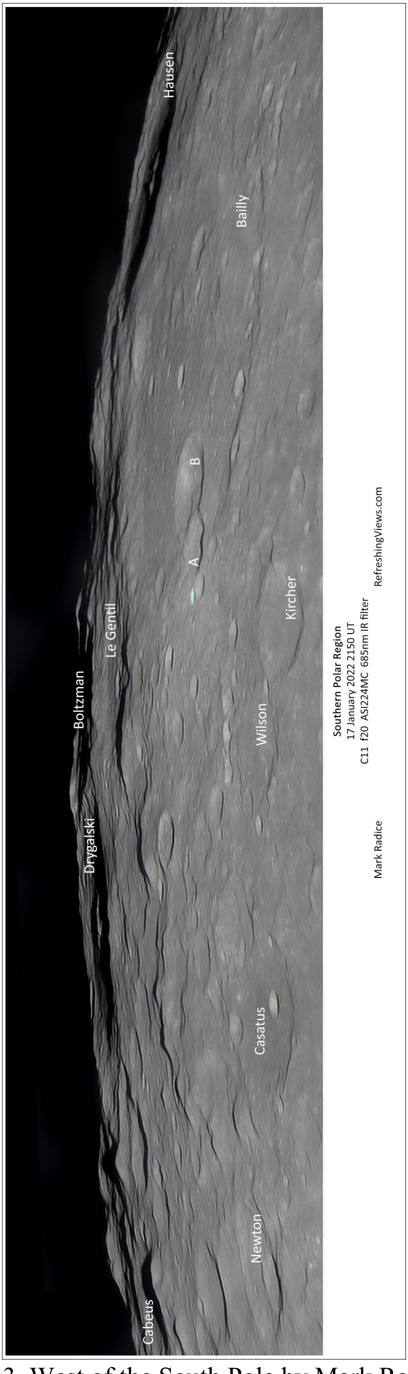

Figure 3. West of the South Pole by Mark Radice

Lunar Swirl – Descartes Area.

The Descartes area as imaged by Alexander Vandenbohede. Date, UT and other details given on the image.

Figure 4. Lunar Swirl in the Descartes Area.

***From the Director*:** Readers may be aware of the rather obvious lunar swirl, Reiner Gamma, but others have also been catalogued and are worth imaging. Alexander has picked, perhaps the second most notable one, and is slightly unusual in that this one occurs in the lunar highlands, not far from the Apollo 16 landing site. Swirls are strange lunar features in that they have a stronger than normal magnetic field that can create a mini-magnetosphere sufficiently strong to deflect "some" charged solar wind particles, for some of the time. They have no compositional differences to surrounding terrain. The only notable difference is grain size. Their origin is a mystery, but some scientists have noted that many appear to be at antipodal points to impact basins on the other side of the Moon.

Southern tip of the Apennines.

Eratosthenes and the southern part of Montes Apenninus, as imaged by Rik Hill on the date and UT given in the image. North is towards the top. Montage was made from parts of two images each made from a stack of 1800 frame AVIs with AVIStack2 (IDL) and then final processed with GIMP 2.6.12 and IrfanView 4.42.

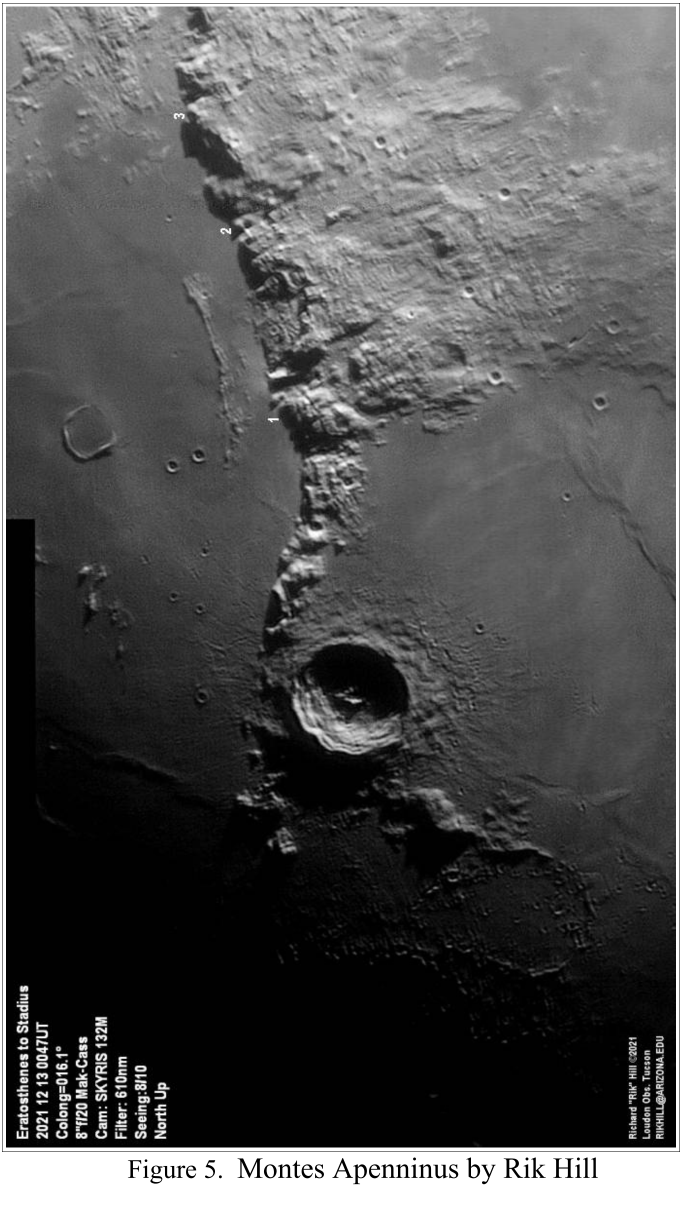

Figure 5. Montes Apenninus by Rik Hill

Rik Hill comments: The night before Copernicus comes into view we get a fine view of his little brother Eratosthenes (60km dia.) seen here just left of centre. The sunlight is catching just the tip of the central peak casting a shadow onto the base of the wonderfully terraced western interior wall. Only when the Sun is this low can you see the ejecta splash to the south on Sinus Aestuum. To the lower left (west) from Eratosthenes is the large ghost crater Stadius (71km) splattered with secondary craters from the Copernicus impact trailing off into the terminator to the north.

To the east of Eratosthenes is a spectacular ridge that is the southern third of the Montes Apenninus with some of the taller peaks on the moon. Mons Wolf (labeled "1") is 3.5 kilometres high, Mons Ampere ("2") is a little shorter at 3 km, but Mons Huygens is a full 5.5 km in height from the floor of Mare Imbrium to its peak. Above this ridge notice another smaller ghost crater, Wallace (27km) to the east of Wallace above the Mons Ampere "2" is the small crater Huxley (3km). The irony in the juxtaposition of these two will not be lost on those familiar with the history of evolutionary biology!

Lunar Eclipse.

A time sequence of the lunar eclipse from 2021 Nov 19 UT 08:59. 09:05, 09:12, 09:17, and 09:21 as taken by Peter Anderson. North is towards the bottom left.

Figure 6. Lunar eclipse sequence by Peter Anderson

Peter comments: The attached set of images (with an 800mm Samyang mirror lens and a Canon 70D) show the approach of the eclipsed Moon to 14 Tauri, which was occulted from my site at 09hrs 19min UT.

A further point of interest is that the layout is exactly reversed to the way it was observed. The camera was mounted parallel to the horizon and the Moon was at low altitude in the north-east just after dusk. As it climbed it moved from the lower right to the upper left in the sky. (The first image was considerably dimmed because of low altitude and the remaining twilight.) So, the order and set out of the images should be reversed to present a true picture! However, we read and scan left to right and expect chronological sequences to follow the same pattern so that is what I have done. The descending diagonal alignment was chosen because it places the image of 14 Tauri closer to the centre of the frame, is more aesthetically pleasing, and provides extra space for the images.

See further contribution from Peter in Occultations section (Ed).

Janssen-Fabricius-Metius

The three craters: Janssen, Fabricius and Metius as imaged by Bob Stuart on the date and UT given in the image.

Bob comments: Managed to do some imaging again …., so craters are illuminated with the "setting sun”. Seeing was Pickering 5, (and -6 degrees C) and the collimation was using the digital collimation camera ….. Seems it does not do a bad job. Managed to get a lot of images, generally duplicates of same region but about 1-2 mins apart.

I also went back to my usual technique of image capture though I did use 150 dark frames (9ms at 109 gain as per exposure) in SharpCap to see if made difference. Not sure is the answer, though only dropped frames on about 3 out of 50 images, usually drop frames on all of them, so maybe it does. So, frames captured very quickly.

Here is one example 5% of 5000 frames in AS3! and Registax, minimal processing in PS CC 2022, (contrast exposure highlights) - Janssen, Fabricius Metius region. The figure is in parts more like a graben, it looks very wide with a flat floor from this angle, as opposed to a rille.

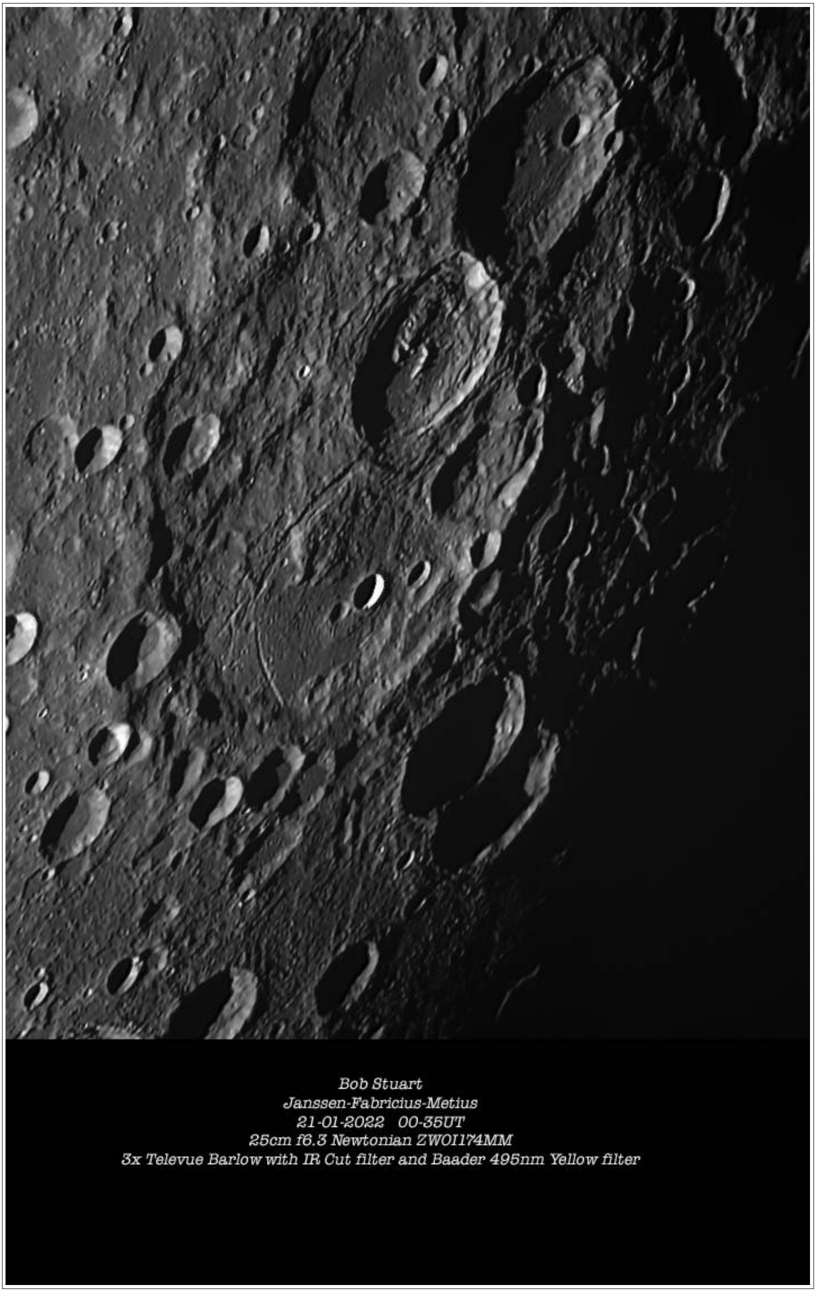

Figure 7. Janssen, Fabricius and Metius as imaged by Bob Stuart. North is towards the top.

J. Herschel.
Imaged by Bill Leatherbarrow on 2022 Jan 14 UT 21:27. North is towards the top.

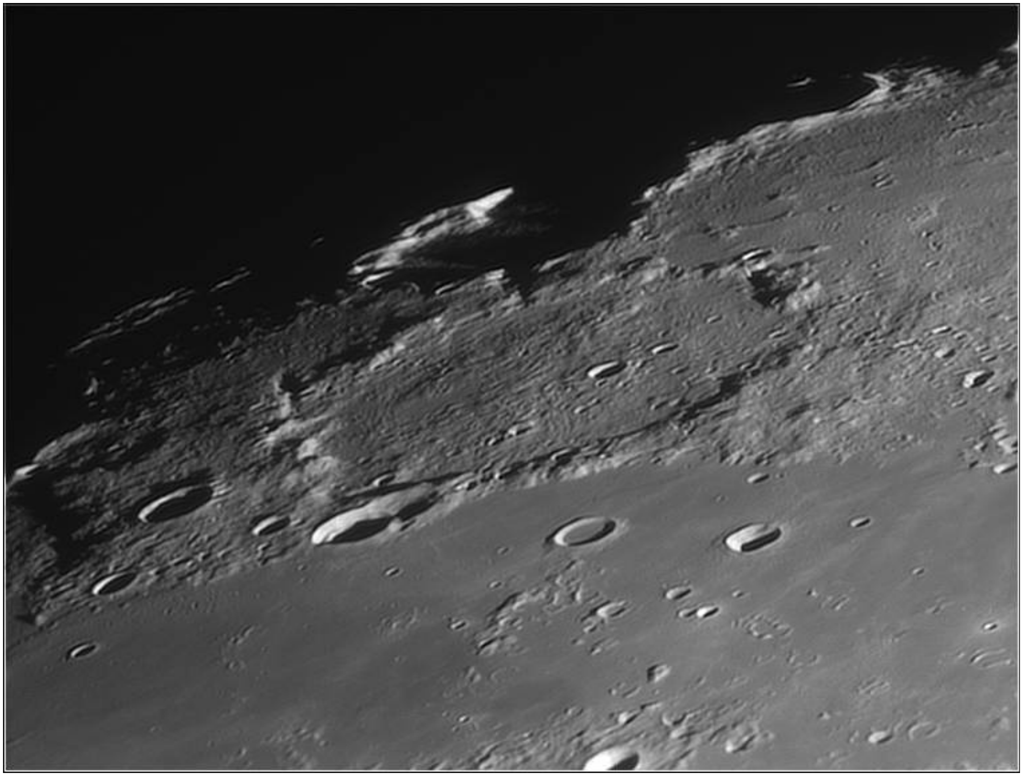

Figure 8. J Herschel by Bill Leatherbarrow North is towards the top.

From the Director: It was very difficult to decide which of the eight images that Bill sent to include in this circular, but in the end, I plumped for J Herschel, which of course is named after the son of the astronomer who discovered Uranus. J. Herschel is a 154 km diameter crater on the NW quadrant of the Moon, near to the limb. The crater rim is fairly degraded, and the floor has a lot of hummocky terrain, no central peak, and has been pepper sprayed with secondary ejecta crater chains. If you are ever down in Bath, and have not seen the: William Herschel Museum, do please drop in as I'm sure you won't be disappointed. The Hercshel's were a very astronomical family: William, John and Caroline all of whom made major contributions to astronomy.

Ina.

A selection of images of the Ina formation as captured by Leo Aerts.

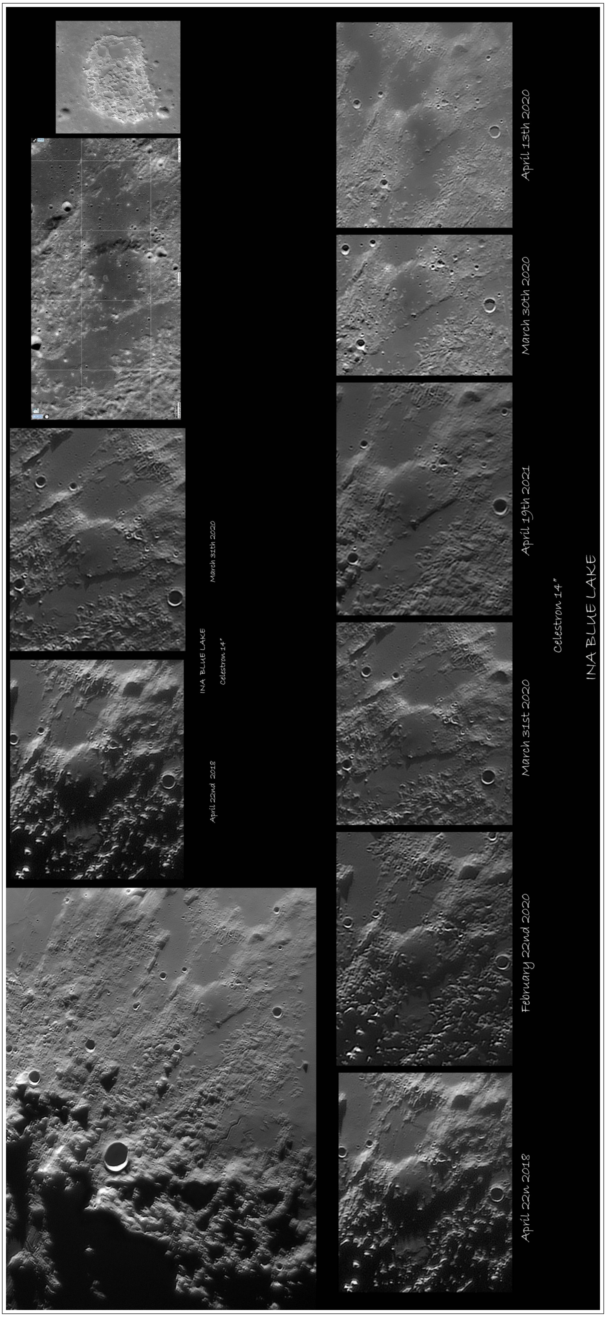

Figure 9. Ina by Leo Aerts. Dates and details are given below each image.

From the Director: Ina is one of the weirdest features on the Moon, and although it can be photographed from Earth, the weird nature was not realized until photographed in detail by the Apollo 15 mission. These showed it was not a crater, but an Irregular Mare Patch (IMP) a Meniscus Hollow. Basically, IMP's can be described as depressions with irregular very young (often blue colour) terrain, with what appear to be extruded globules of lava on top of this. There are other, features like this, for example at the bottom of Hyginus crater. As Ina is a very small 3 x 2 km “D” shaped depression we obviously cannot reveal its internal detail from Earth, but at least we can see its location and shape in Leo’s images.

Mare Humboldtianum.
By David Finnigan.

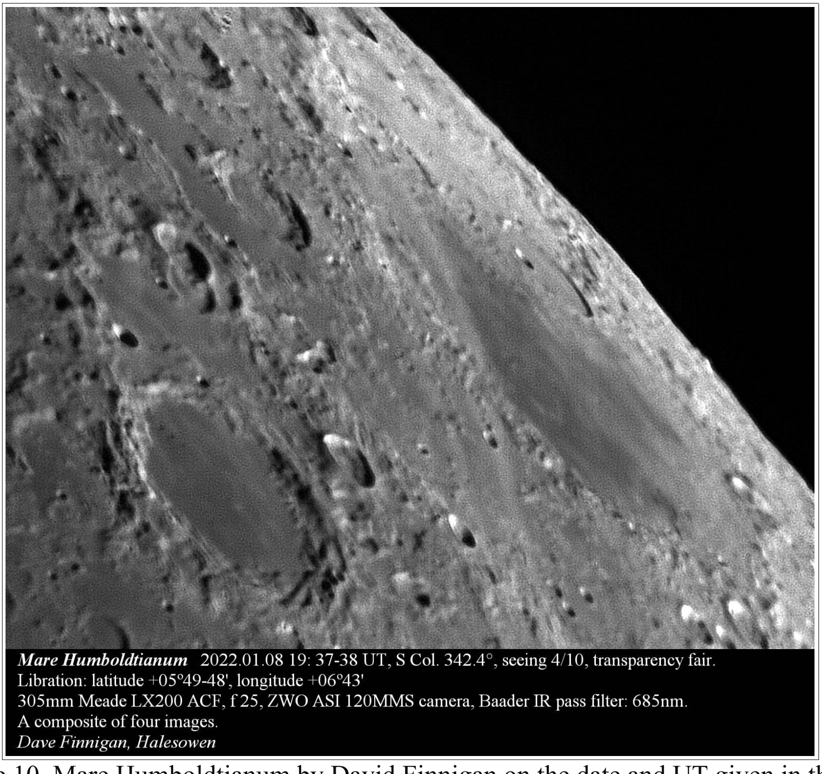

Figure.10. Mare Humboldtianum by David Finnigan on the date and UT given in the image. North is towards the top.

From the Director**:** Mare Humboldtianum is on the NE limb of the Moon, north of Mare Crisium, but only well presented when the libration is favourable. The basin dates from the Nectarian era and is 600 km in diameter, though only the inner part has been flooded by dark mare material. Endymion crater is further away from the limb and 125 km in diameter. Like Plato it has dark lava flooded floor.

Northern Mare Imbrium.

By John Axtell on 2021 Jan 13 at UT 21:25. A burst of ten images were taken on an iPhone SE, clamped onto a 19" Obsession Classic telescope. The image was darkened slightly using Adjust Curves in Fast Stone Image Viewer, which was also used for the rotating and cropping.

Figure 11. Northern Mare Imbrium by John Axtel.

***From the Director*:** John's image shows what amazing results can be obtained with a simple camera phone attached to the eyepiece. I have taken the liberty of adding an enlarged insert for Mons Pico (south of Plato) as it shows a wealth of detail on its western flanks – always a good test for image resolution. One thing I have noticed over mobile phone, and indeed older webcam images, is detail in low contrast areas is often lacking, even with stacked images – examine the floor of Plato for example. Despite this, a very pleasing image. Although John's 19" aperture had helped obviously with the resolution. he is now planning on switching to an ASI 120 camera, so we shall be eagerly awaiting some new results.

Parry and Tolansky

A Sketch of Parry and Tolansky craters by Paul Abel.

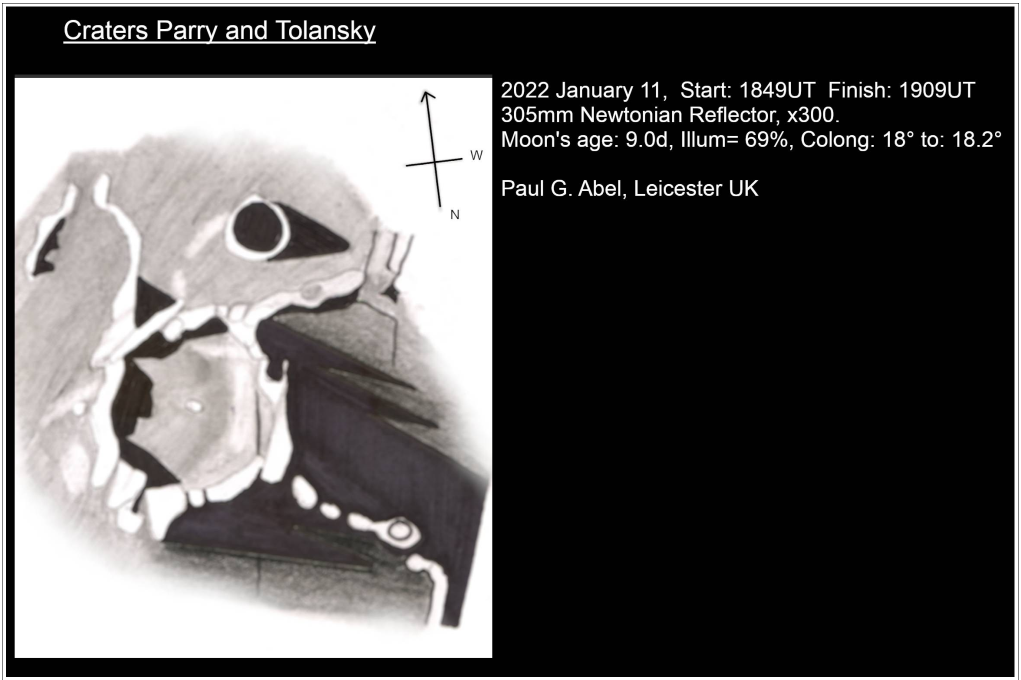

Figure 10. Sketch of Parry and Tolansky craters by Paul Abel. See the sketch for details of the date, UT, north direction and equipment used.

***From the Director*:** Just south of/adjoining Fra Mauro crater (see Fig 2) we find an irregular 48 km diameter crater, Parry. Look carefully in Paul's sketch and you can see a dark line on the floor near the NW wall. This is one of the two grabens that bisect the floor of the crater. Tolansky, on the other hand is a smaller 13 km diameter circular crater. Although shadow filled here the floor also has an infilling that makes it flat inside.

……

Lunar Occultations February 2022

By Tim Hayme

Time capsule: 50 year ago in the 1972 issue: With thanks to *Stuart Morris* for the LSC archives. https://britastro.org/downloads/10167

- P Moore: The LS program is revised into sections: Small telescopes, Project Moonhole, South Polar charting, TLP, Photographic, Occultations. (TLP observers listed)
- G Taylor: The RGO formally requests observation of occultations
- G Falworth: Apollo 16 event timings

Lunar eclipse and emergence of 13 Tauri

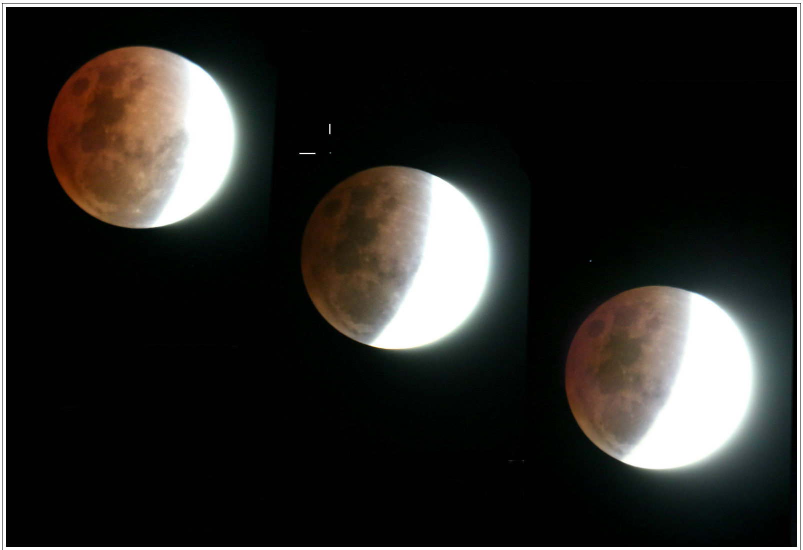

Fig.1. 13-Tau re-appearing from behind the eclipsed limb.

Peter Anderson (Brisbane, Australia) sends this sequence of the star 13-Tau re-appearing from behind the eclipsed limb on 2021 Nov 19h. The images(left to right) were exposed at 0941(just before reappearance)0954 and 0959UT. The image has been cropped for clarity.

The full image and image details can be seen here: https://britastro.org/observations/observation.php?

id=20211229_011646_f7eeca9b8d193406

Tim Haymes:

I would like to use Peter's images to illustrate the nomenclature used by Occult4 prediction software when describing Lunar Eclipse phenomena. See the predictions on page 41 of the 2021 BAAH as examples. I use these diagrams and refer to the images. The Prediction is for Sydney. The diagram is taken from SkyMap Pro 11, and the star (13 Tau) is on the limb at the intersection of the blue lines in Fig-2/3

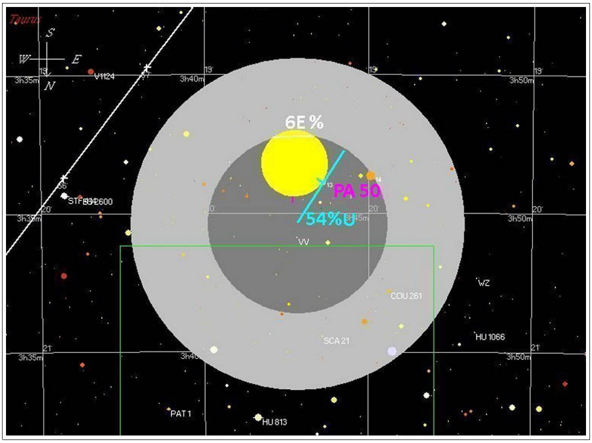

Fig-2. DD on 2021 Nov 19, 0840UT.

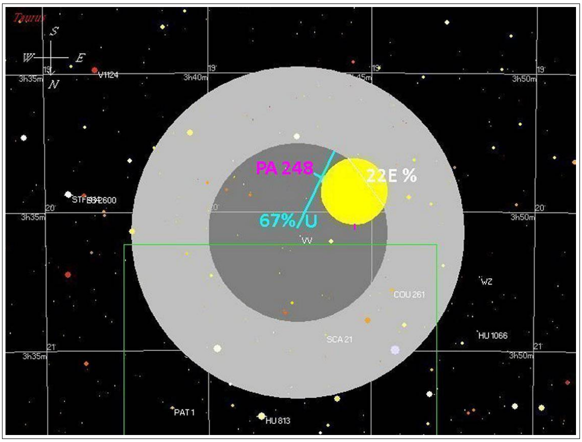

Fig-3. RD on 2021 Nov 19, 0945UT.

Occult4 describes the lunar illumination and position of the star:

%ill is the amount of Moon not in the Umbra.

CA s cusp angle, but given in terms of distance from the centre of the Umbral shadow.

In Fig-2 %ill = 6E, CA = 54U.

In Fif-2 %ill =22E, CA = 67U.

The percentage illumination can be appreciate but 54U and 67U are not particularly obvious from the aspect of observability. In Fig-2, 54U is a %age measure of the depth of the star within the Umbra. In Fig-3 the star is nearer the Umbra’s edge and CA is 67U. When an observer computes circumstance for a particular location (like “Home”) then some additional parameter are displayed in Occult4. The most useful is the position angle (PA) around the limb measured from the sky north-point towards the east. These values are shown on the diagram in pink text:Fig-2, PA = 50; Fig-3, PA = 248. For future eclipse predictions, the LSC will aim to include the PA as well as the Umbral depth. I invite comments.

Review of O-C values continued from LSC 2022 January

An Occult4 re-analysis was explained in the 2022 Jan LSC. Since then the archive files has been re-reduced by D Herald for use with Occult 4.2022.1.1 The updated re-reduced O-C in shown in this amended table.

Original circular:

OCCULTATION OBSERVATION.   D.Hall

1970	ZC No	Ph	O-C (secs of Arc)
Dec. 6	3508	1	−0.49
" 20	1635	2	−0.36
1971			
Jan. 2	3467	1	+0.07
Feb. 3	538	1	−0.81
" 3	555	1	+0.15
" 3	571	1	−0.12
" 14	1759	2	+0.06
May 2	1396	1	+0.01
" 3	1486	1	−0.13
" 4	1497	1	+0.09
Aug 8	3380	2	+0.23

List of occultations reductions asked for by G.Kirby (Nov.Circular).

I agree that this is the most informative way of reporting these observations and propose to withhold further reports until after reduction by the R.G.O. I am doubtful, however, of the value of an overall analysis of one's own results. My own total of 16 observations (after excluding those poorly determined) produce a mean of −0".10 with a standard deviation of 0".29. But these figures refer mainly to a different series of events to those analysed by G.Kirby. More rewarding in the long

Amended Table:

D Hall		O-C ("arc)		
Date	ZC	orig	re-reduced	
1970 Dec 6,	3508,	-0.49	+0.19	b
1970 Dec 20,	1635,	-0.36	-0.39	-
1971 Jan 02,	3467,	+0.07	+0.01	b
1971 Feb 03,	**0538,**	**-0.81**	**+0.29**	**b**
	0555,	+0.15	+0.16	-
	0571,	-0.12	+0.29	w
1971 Feb 14,	1759,	+0.06	-0.27	w
1971 May 02,	1396,	+0.01	+0.05	-
1971 May 03,	1486,	-0.13	+0.20	-
1971 May 04,	1497,	+0.09	-0.01	b
1971 Aug 08,	3380,	+0.23	-0.34	w

Version 2022.1.1 has an updated reduction, with corrections for limb profile and PE include in the datasets where absent. (info via IOTA)

Conclusion.
Some results are better (b), some slightly worse (w), and some have no real change (-). The differences are small. Values of 0.5 to 1.0 "arc were considered poor. ZC 0538 had a -0.81 residual. This is now +0.29. So I conclude Mr Hall's observation quality was good without doubt. Only a small selection of original O-C values are reported in the LSC.

Observations received.

T Haymes: C11 and QHY174mGPS* CMOS camera at 20ms exposure.

```
DD S146869     m 8.8 CA42N   at 2022-01-07,  18:40:54.37ut  O-C +0.02
DD X186360     m10.6 CA19N   at 2022-01-07,  18:42:32.58ut  O-C +0.01
DD S128849**   m 8.6 CA52N   at 2022-01-08,  21:43:36.54ut  O-C -0.01
```

[Key: ** = There is a light curve in the Occult database from an observation of a previous event.
* = USB3 Recording with Sharp Cap 4.0.8395]

My experiences in visually timing lunar occultations.
Peter Anderson is a long time Australian visual lunar occultation observer and BAA LS member. He writes:

I commenced the timing of lunar occultation of stars in 1976. The number of these observations increased significantly in 1980 with the completion of my observatory, and by the end of 2021 had reached 10,063 observations. Though I have always observed from the same site at my home, there have been equipment changes over the years. At first I was using an 8″ reflector. With the establishment of my observatory in 1980 until 2016, I used a 16″ F6 reflector generally at x198. In 2014 I purchased a Celestron 14″ SCT and in the next two years I used it concurrently with the 16″ that I then sold in 2016 when it was getting difficult to climb the ladder to observe. I continue to use the C14 as my main instrument, operating at x156. On occasion though, my C11 (mounted on wheels), is used at the southern end of the observatory when trees get in the way of the 14″ during the crescent phases in autumn. I then use between x73 and x146 magnifications.

I find observing occultations to be a rewarding interest. The event is demonstrably occurring in real time. While variable star and other observers have leeway as to when they choose to observe, and variable star enthusiasts may observe as many as time permits, the occultation observer is governed by the number and position of the stars and the motion of the Moon. Sometimes events come thick and fast and at other times there are long waits between each.

[Tim Haymes adds: With a lap mode stopwatch, Peter reports timings to +/- 0.1s, at a typical PE of -0.3sec, although he may adjust this depending on the degree of difficulty. He uses Occult4 software for preliminary analysis and to check for poor timings. The time signal comes from SW radio (WWVH, Hawaii) or a GPS “beeper” box]
Note on WWVH: https://www.nist.gov/pml/time-and-frequency-division/time-distribution/radio-station-wwvh

Occultation Highlights for February 2022.

Day	UT	Star / Event
6th	1645:	Tau Aquarii occulted in twilight.
10th	1800-2300,	three stars in Taurus and NGC 1746
26th	0347	5 Libra, Reappearance at the Dark limb (RD). Suspect double.
26th	0527	8 Libra (near Alpha) RD
26th	0535	alpha Libra RD

Note on Observing:

General predictions for 2022 February.(Times as other locations will +/- a few minutes)

Longitude 1 18 46 W , Latitude 51 55 41 N, Alt. 119m; Mag Limit 8.0

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Az	CA	Notes
22	Feb	3	18	5	50.0	D	3438	B3	7.7	7.8	8+	33	-11	13	234	64N	
22	Feb	3	19	12	27.4	D	3442	F5	7.9	7.6	8+	33		5	248	29N	
22	Feb	4	19	41	6.4	D	128642	M*	7.4*	6.5	15+	46		12	248	14N	
22	Feb	5	18	7	38.5	D	109557	F8	8.0*	7.8	23+	57	-11	34	219	18N	
22	Feb	5	20	22	45.1	D	109613	F6	7.6*	7.3	24+	58		18	251	72N	Dbl*
22	Feb	8	19	26	16.8	D	482	F0	7.8	7.6	52+	92		53	211	69N	
22	Feb	10	1	6	32.3	D	631	F0	5.6*	5.5	63+	105		16	284	73S	51 Tau
22	Feb	10	1	44	33.8	D	634	A0	5.3	5.4	63+	106		11	291	71N	56 Tau
22	Feb	10	18	38	11.1	D	742	G8	5.8	5.2	70+	114		60	150	50N	99 Tau
22	Feb	10	20	30	5.4	D	76885	F2	7.8	7.6	71+	115		61	202	36N	
22	Feb	10	23	7	47.6	D	76947	K0	7.7	7.0	71+	115		43	253	37S	NGC1746
22	Feb	11	0	47	9.0	D	767	B2	5.5		72+	116		28	274	70N	103 Tau
22	Feb	11	18	9	12.2	D	77593	K2	7.3	6.5	78+	125	-9	53	121	37N	Dbl*
22	Feb	11	23	32	35.5	D	77778	K0	8.0	7.4	80+	126		48	249	70S	
22	Feb	11	23	59	47.7	D	902	K0	6.6	6.1	80+	127		44	256	60N	
22	Feb	12	0	1	9	m	900	B1	4.8	4.9	80+	127		44	256	0N	139 Tau
22	Feb	12	0	6	40	Gr	900	B1	4.8	4.9	80+	127		43	** GRAZE:		
22	Feb	12	2	42	36.8	D	918	K0	7.0	6.5	81+	128		20	286	55S	127
22	Feb	12	23	28	46.3	D	1046	F8	7.0	6.7	87+	137		55	234	30S	158 Dbl*
22	Feb	13	3	48	44.9	D	1062	B8	6.4*	6.5	88+	139		18	289	13N	40 Gem
22	Feb	13	21	4	46.1	D	79610	F8	7.2*	7.0	92+	148		60	148	31S	
22	Feb	15	19	43	8.3	D	1393	G7	6.5*	6.0	99+	169		33	100	78S	
22	Feb	17	22	17	18.4	R	1612	F5	7.3	7.1	98-	164		34	121	74S	
22	Feb	19	22	9	50	Gr	1825	G8	5.9	5.5	88-	140		11	** GRAZE:		
22	Feb	21	1	7	29.9	R	1951	K0	7.1*	6.6	80-	126		22	139	49N	81 Vir
22	Feb	21	4	4	25.1	R	1962	M2	5.0	4.2	79-	125		29	186	77N	82 Vir
22	Feb	24	3	57	12.8	R	2357	B3	6.8		47-	87		9	148	59N	
22	Feb	24	4	0	1.6	R	184381	B2	5.7		47-	87		9	149	53N	Dbl*
22	Feb	24	4	0	8.3	R	2359	B2	5.0	4.9	47-	87		9	149	53N	rho Oph
22	Mar	5	20	39	42.1	D	219	K4	4.8*	4.1	11+	38		5	273	85N	mu Psc

Predictions up to March 5th

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. (-ve indicates bright limb)
Mag(v)* = asterisk indicates a light curve is available in Occult-4

Star No:
1/2/3/4 digits = Zodiacal catalogue (ZC) 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.
H denotes the HIPparchus 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.

Detailed predictions at your location for 1 year are available upon request. Ask the **Occultation Subsection Coordinator**: tvh dot observatory at btinternet dot com

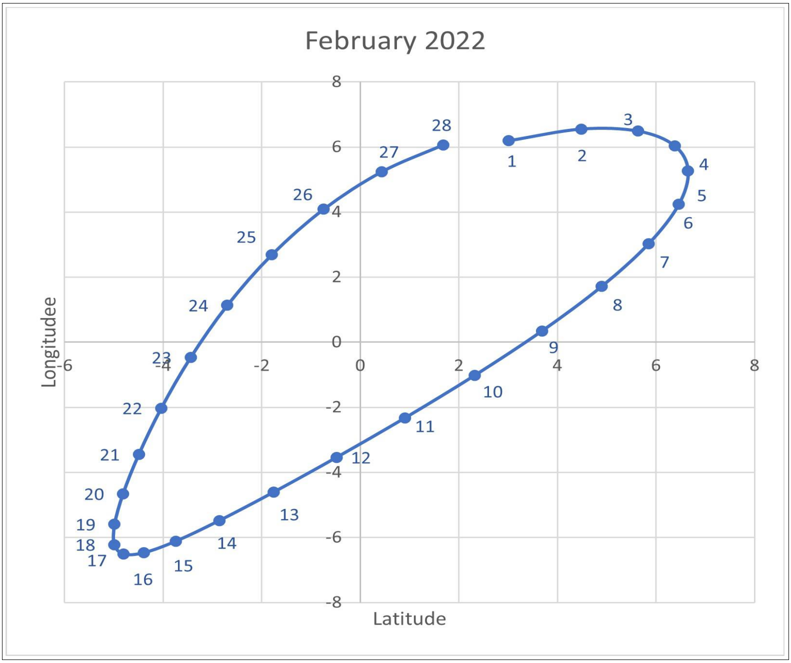

Fig.4. Libration chart for February 2022.

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Lunar domes (part LV): A lunar cone in Mare Crisium

By Raffaello Lena

The Crisium Basin formed near the end of the period of high cratering flux, dated as 4.05-4.13 billion years ago or Giga annum-Ga (Wilhelms, 1973). Mare Spumans and Mare Undarum are presumed to be within the continuous Crisium ejecta. The surrounding basin material is of the Nectarian epoch, with the mare basalt being of the Upper Imbrian epoch (Olson and Wilhelms, 1973 and references therein). After the formation of the Crisium Basin, mare materials were emplaced in the central basin and in the peripheral troughs around the basin. Most of the mare materials in the circum-basin troughs consist of localized, isolated patches which are bounded by structures approximately radial and concentric to the basin. Mare Undarum and the northern part of Mare Spumans occupy a trough between the 340- and 485-km raised rings (De Hon, 1975).

The Crisium Basin concentric structure consists of a series of raised rings and intervening troughs. Three rugged rings are delineated in the circum-mare terra and another lies within the mare (Wilhelms, 1973). Rings are approximately 210, 250, 340, and 485 km from the basin center. The raised rings are composed of pre-basin rock and overlying basin ejecta.

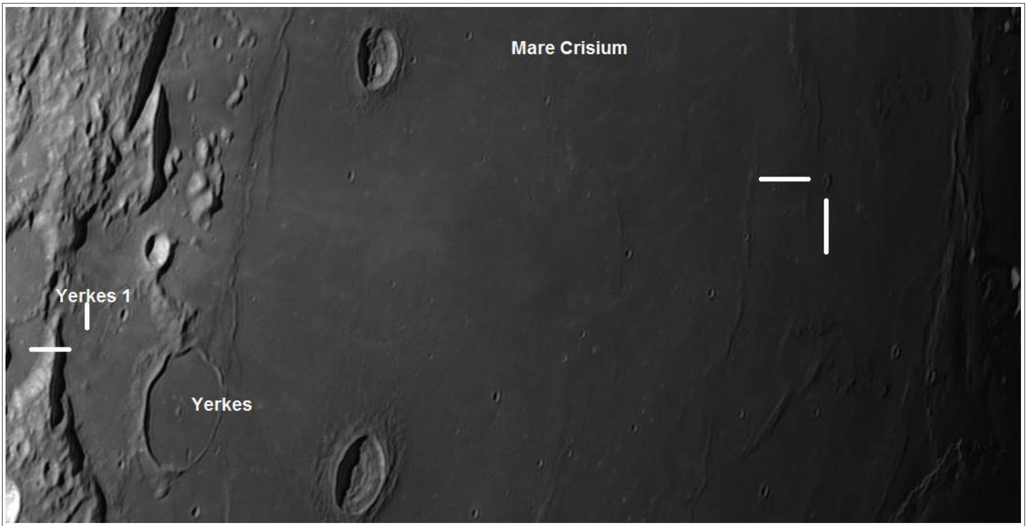

Figure 1. Image taken by Teodorescu using a 355 mm Newtonian telescope and ASI 174MM camera. The examined feature is marked with white lines. Note to the east the dome Yerkes 1.

An overview of the geologic setting of Mare Crisium is reported by Lu et al. (2021). The earliest basaltic volcanism in the Crisium basin erupted around 3.74 Ga, forming the oldest middle-to-high-Ti mare basalts (6~10 wt % TiO_2); basalt filled most area of the Crisium basin during the Imbrian period, defined as Im1 unit. The subsequent low-to-middle basaltic volcanism occurred and flooded the center and western area (i.e., Im2 and Im3 unit) at ~3.5 Ga, superposed on the prominent high-Ti basalts (Lu et al., 2021). Furthermore Im2 is the largest maria plain. This geologic unit contains a medium TiO_2 content (4~5 wt %) and medium-to-high FeO content (15~22 wt %). The Eratosthenian-age basaltic volcanism erupted, and widespread lava flows filled the northern and eastern area of the Crisium basin. In this period, large craters Picard and Peirce were generated and the subsurface high-TiO_2 basalt in the western area was excavated. In the Copernican period, a wide range of volcanism has ceased, but the impact events continued to reshape the terrain and garden the surface materials of the Crisium basin. Contaminated ejecta and distal material transports from Proclus and other craters in the highlands could overlap and complicate the mixing of local mare basalts characterized by very low-Ti (~1 wt %) materials (Lu et al., 2021).

In this note I will describe a horseshoe feature, located in Mare Crisium, at 61.9°E and 18.5°N including telescopic images. A terrestrial telescopic image of this examined feature is shown in Fig. 1. It was taken by Teodorescu on October 3, 2020 at 23:02 UT.An enlarged image of this horseshoe like-cone is shown in Fig. 2. This could be of the same nature as the so-called cinder cone near Lassell D (Lena et al., 2013).

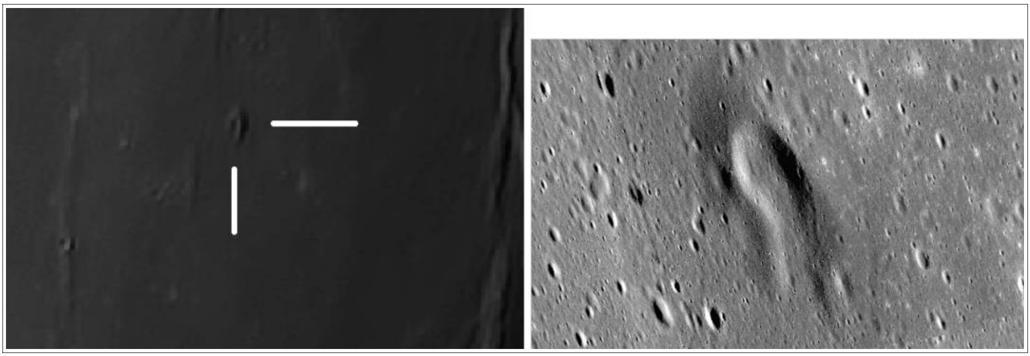

Figure 2. (left) Enlarged image of the feature taken by Teodorescu using a 355 mm Newtonian telescope and ASI 174MM camera. The examined feature is marked with white lines. (right) WAC image of the feature described in this work.

Another image of this region was made by Robert Cazilhac on December 21, 2021 using a Schmidt Cassegrain 12"F/D20 and an ASI 1600 MMC camera (Fig. 3).

In the USGS I-707, Cleomedes quadrangle, it is described as *Eid unit* corresponding to small irregular dome with relatively large and breached depression at summit, likely a lunar cone:

https://www.lpi.usra.edu/resources/mapcatalog/usgs/I707/150dpi.jpg

As visible in Fig. 4, the WAC image of this feature shows its real nature. In Fig. 4 the foreshortening effect is deleted and the image is seen as cylindrical projection.

It has a breached rim and displays a lava channel starting from the summit, which is also detectable in terrestrial images (see Figs. 1-3). Lunar volcanic cones form from explosive eruptions with the release of large amounts of dissolved gas (called degassing) when viscous magma rises to slowly fill the volcanic vent. ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile (Figs. 5-6). The examined cone is topographically higher by about 180± 20m than its surroundings. The diameter is determined to 6.0 ± 0.3km, yielding an average flank slope angle of 3.4° ± 0.3° but in some part the slope angle amounts to 8°.

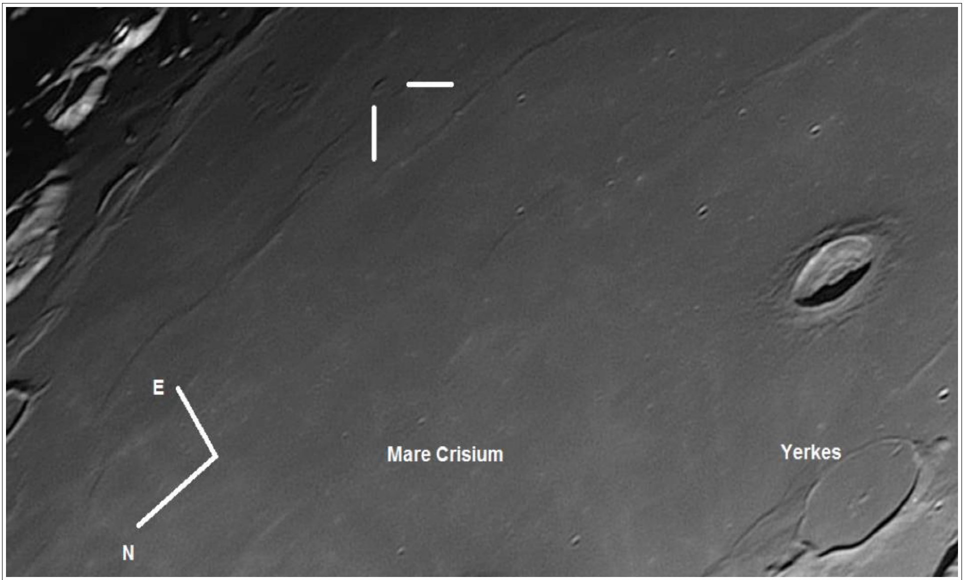

Figure 3. Image taken by Cazilhac. The examined feature is marked with white lines. In this image north is to the bottom on the left.

The features under investigation can be compared with the known cones Isis and Osiris. Isis, located in Mare Serenitatis (18.96°N, 27.48°E), is a 1.7km diameter cone that is also C-shaped, smooth-sided, and has a gap and a lava channel (Fig. 8). Isis is 60 m in height and has a slope of 4.0°. This feature is similar in morphology to some Marius Hills cones. Osiris is another similar volcanic construct ~2.3 km in diameter, located southeast of Isis (18.60°N, 27.60°E). It does not have a gap in the cone wall. This feature is 70m high, and has a slope of 3.54°. Both of these cones are thus similar to some cones of the Marius Hills, but have lower slopes.

The lunar cone in Crisium, examined in this note, is located in the Im2 unit of Imbrian-age basalts, based on the data described by Lu et al. (2021) corresponding to age of ~3.49 Ga. Scenarios explaining the observed asymmetry of C-shaped cones include: (1) the non-uniform eruption and emplacement of pyroclastics and lava around the vent resulting in asymmetrical construction of the rim; (2) pre-existing topography directs erupting lavas away from the vent in the downslope direction and prevents the construction of the downslope wall, resulting in an asymmetrical cone; (3) a directional weakness formed in a symmetrical cone due to a pileup of lava and/or pyroclastics on one side results in the collapse of one wall of the cone and is accompanied by a breakout of lava from the cone wall; (4) pre-existing topography controls the flow direction of erupting lavas and results in the destruction of the downslope rim through thermal erosion.

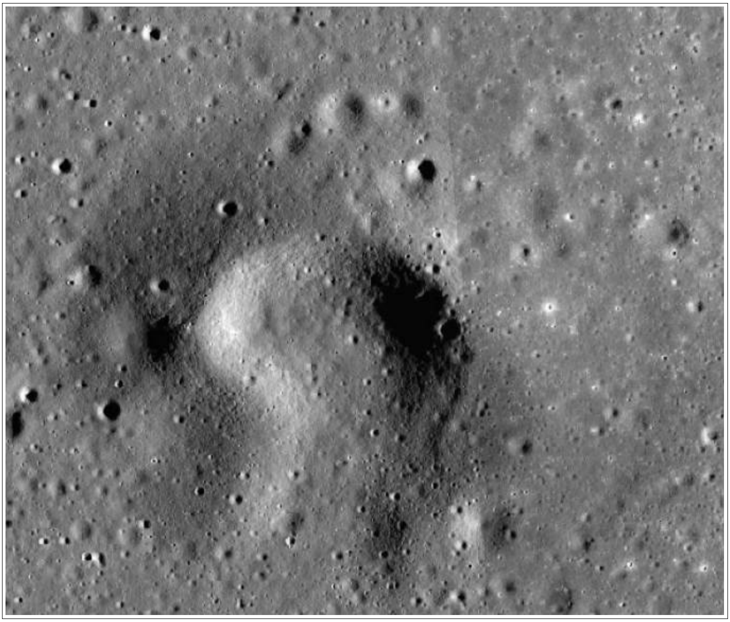

Figure 4. WAC image of the lunar cone with relatively large and breached depression at summit.

A realistic view based on NAC digital elevation-*QuickMap Terrain Shadows*- displays the shape of the volcanic construct (3D reconstruction shown in Fig. 7).

Analyses of the Diviner CF map reveals that it does not display the short wavelength CF position characterizes silica-rich lithologies like the Gruithuisen domes. The average CF position is 8.35 ± 0.05 µm; this value is not different from the average CF position of the typical basaltic *maria*, which is 8.30-8.40µm. Hence, it is not enriched in silica relative to the surrounding mare units.

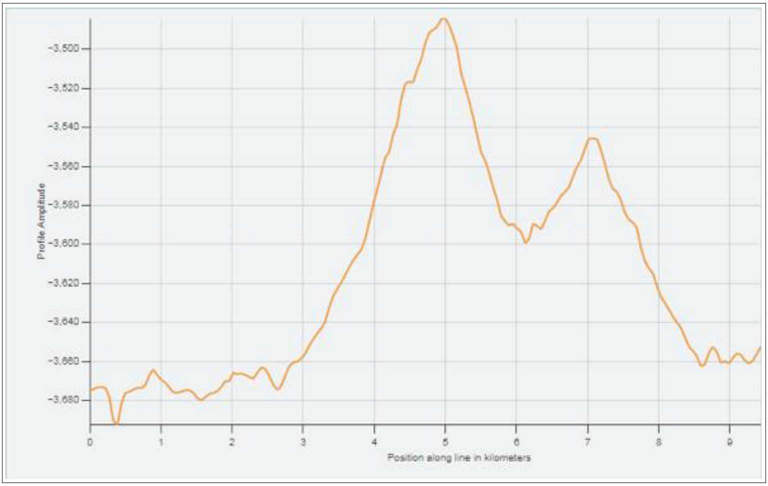

Figure 5. LRO WAC-derived surface elevation plot in East-West direction based on LOLA DEM.

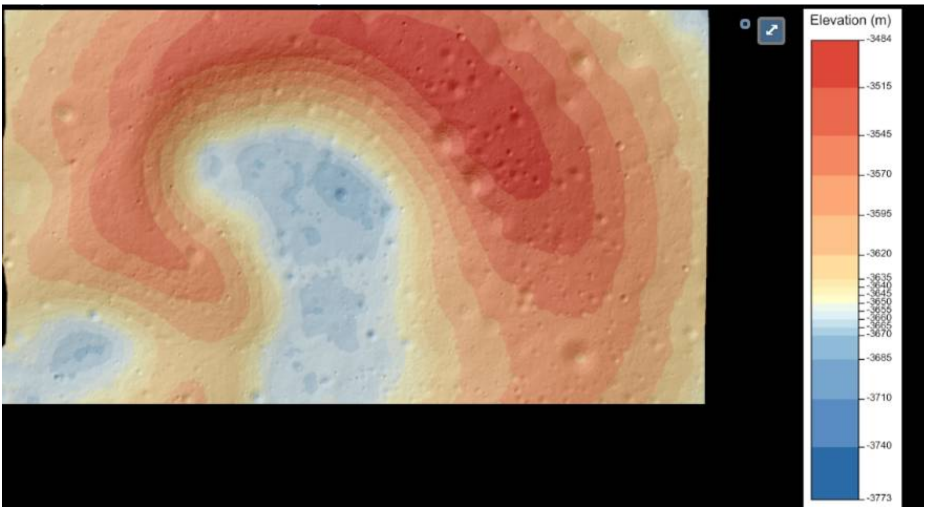

Figure 6. ACT REACT Quick Map tool. Elevation map.

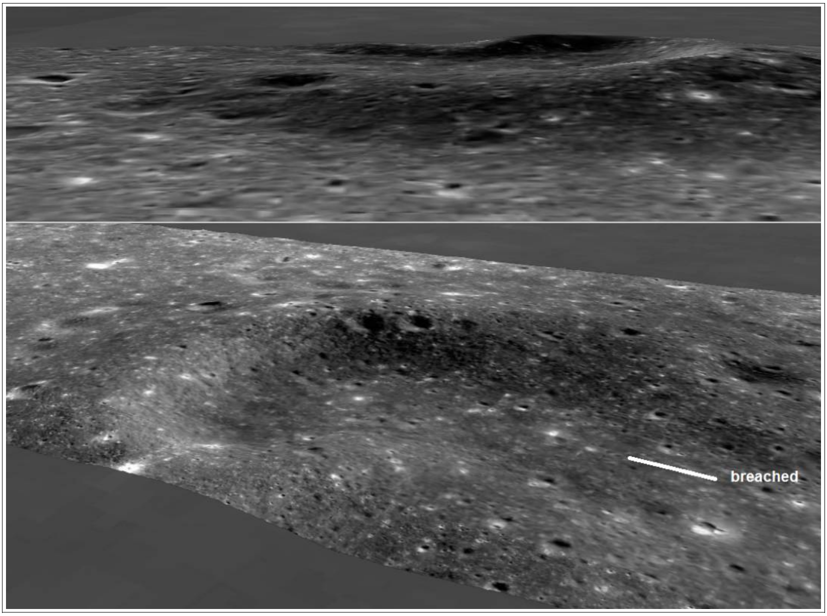

Figure 7. ACT REACT Quick Map tool 3D reconstruction as seen from two different directions based on NAC imagery. Note the breached rim and the lava channel.

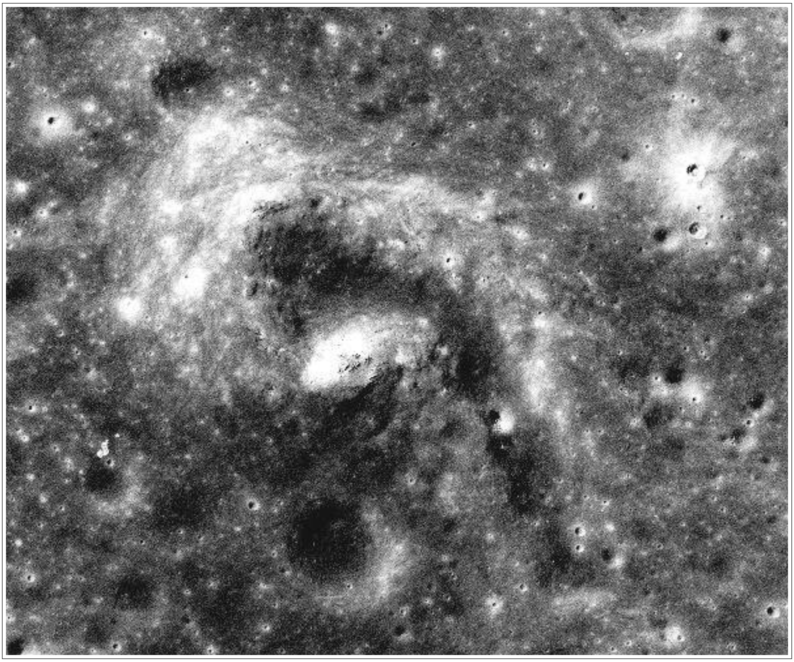

Figure 8. Apollo imagery showing the breached cone Isis in Mare Serenitatis. AS17-P-2760.

The mafic minerals (e.g., pyroxene and olivine) of mare basalts can be identified through their characteristic spectral absorption features. Pyroxene displays two absorption peaks at approximately 1,000nm (Band I) and 2,000nm (Band II) (Besse et al., 2014; Klima et al., 2007). In contrast, the olivine reflectance spectrum is revealed by broad and asymmetric 1,000nm absorption, but lacks the 2,000nm absorption. The broad Band I absorption in olivine is caused by three distinct absorption bands [Besse et al., 2011; Besse et al., 2014]. The central absorption, located just beyond 1,000nm, is caused by iron in the M2 crystallographic site. The two weaker absorptions near 850 and 1,250nm are the result of iron in the M1 site. The Band I "secondary" absorption near 1,250nm allows olivine to be detected when admixed with the spectrally "stronger" pyroxene. The band centers are influenced by the amount of Fe^{2+} and Ca^{2+}: with increasing Fe^{2+} and Ca^{2+}, the band centers move slightly to the longer wavelength. However, in the case of olivine-pyroxene mixtures, Band I is dependent on the relative abundances of both olivine and pyroxene. The spectrum of the cone, derived using M^3 data set, is shown in Fig. 9.

Thus the cone displays a mixture of pyroxenes (orthopyrexenes and clinopyroxenes) and olivine. The Multiband Imager (MI) data has been used for compositional analysis. MI is a high-resolution multispectral imaging instrument on board SELENE. It has five visible (VIS) bands (415 nm, 750 nm, 900 nm, 950 nm, and 1000 nm) and four near-infrared bands (1000 nm, 1050 nm, 1250 nm and 1550 nm).

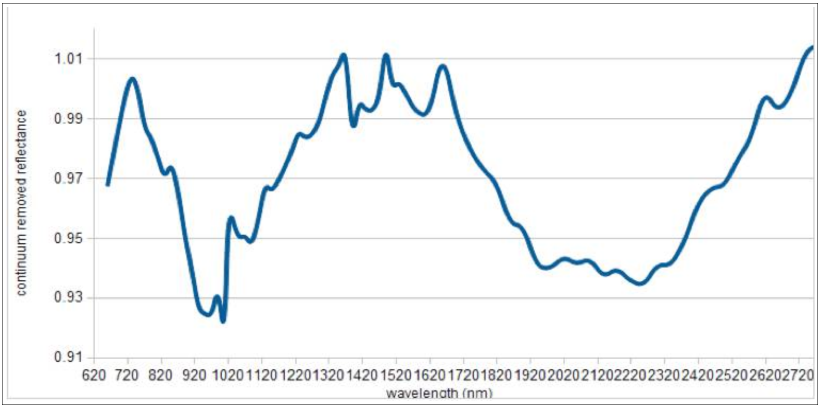

Figure 9. M^3 spectrum of the lunar cone described in this article. The spectrum displays broad, composite absorption feature over 1000nm having the greatest affinity to typical olivine spectra admixed with pyroxenes.

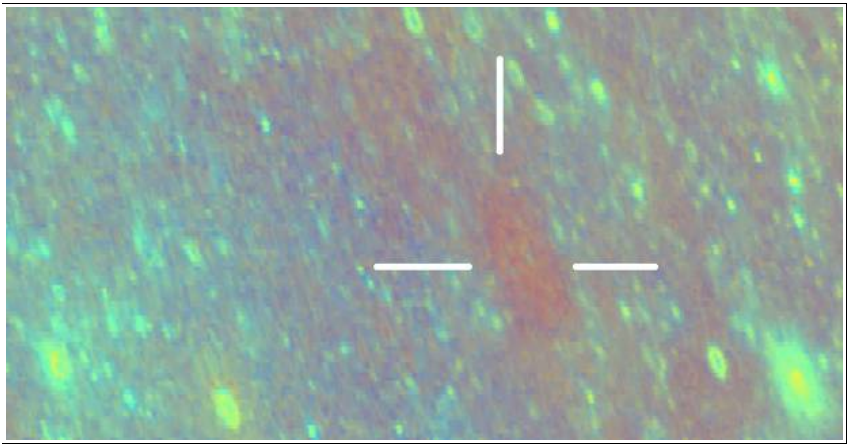

Figure 10. Clementine colour ratio image obtained assigning the R_{750}/R_{415}, R_{750}/R_{950} and R_{415}/R_{750} into the red, green, and blue channels, respectively.

The VIS bands of MI have the same center wavelengths as those of the Clementine UV/VIS camera but have much higher spatial resolution (20 m/pixel). The Clementine color ratio image displays a red color in the area of this breached cone (Fig. 10).

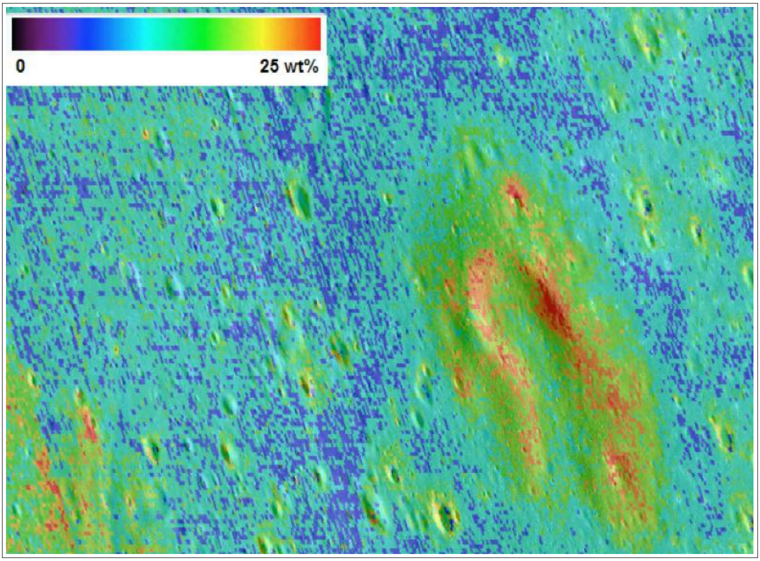

Figure 11. Olivine wt% map of the examined region including the lunar cone.

Based on the Multiband Imager (MI) dataset the olivine signatures are also detected on the rims and floor of small craters (Figure 11) and inside and outside of the described lunar cone. In these small craters, small-body impact events were able to excavate and expose substrate olivine-rich materials in the lunar subsurface. The highest olivine concentrations identified in the lunar cone may represent a final product slightly differing in olivine rich basaltic composition.

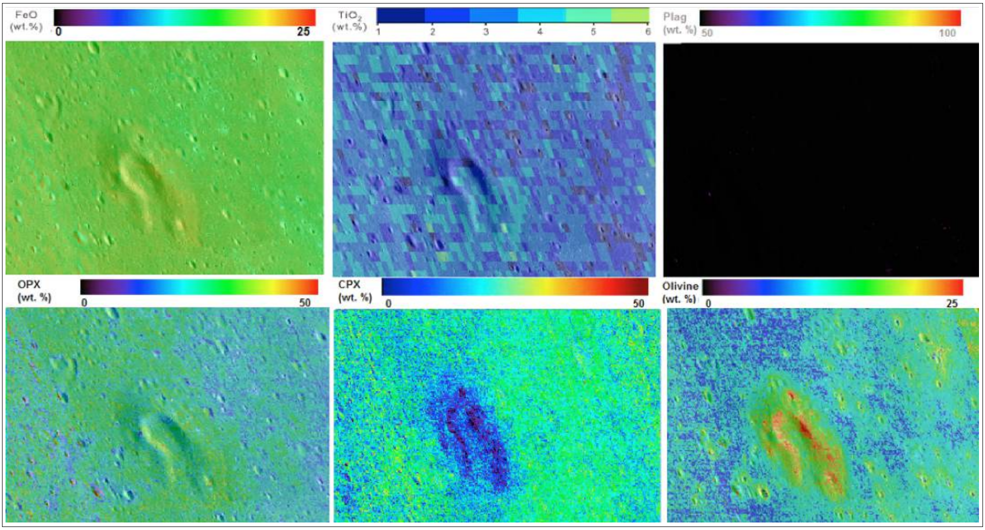

Figure 12: Top (left) Fe0, (middle) Ti0$_2$, (right) plagioclase. Bottom (left) orthopyroxene, (middle) clinopyroxene, (right) olivine content. Derived abundance maps in wt%.

The lunar cone displays a TiO_2 content of 2.0-4.5 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 16.0 wt % to 19.0 wt % like the nearby mare units.

This lunar cone has an enhanced abundance of orthopyroxene (from 23 wt % to 33 wt %) and a lower abundance of clinopyroxene (5.0-16.0 wt %) if compared with nearby mare units (30-33 wt %). Furthermore the lower clinopyroxene content of the lunar cone is detected where the olivine abundance is higher, suggesting the presence, in the examined region, of different volcanic products of differing composition (Fig. 11).

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Krieger.
By Barry Fitz-Gerald.

Nigel Longshaw's recent article on Krieger[1] bought my attention to this somewhat overlooked crater which is located just to the north of Aristarchus and Prinz with its spectacular tangle of sinuous rilles. From a geological perspective, it has a lot of local competition, but a glance at some of the excellent images available from Apollo, LRO and SELENE shows that it is far from being just a mare flooded crater, and has a rather interesting story to tell.

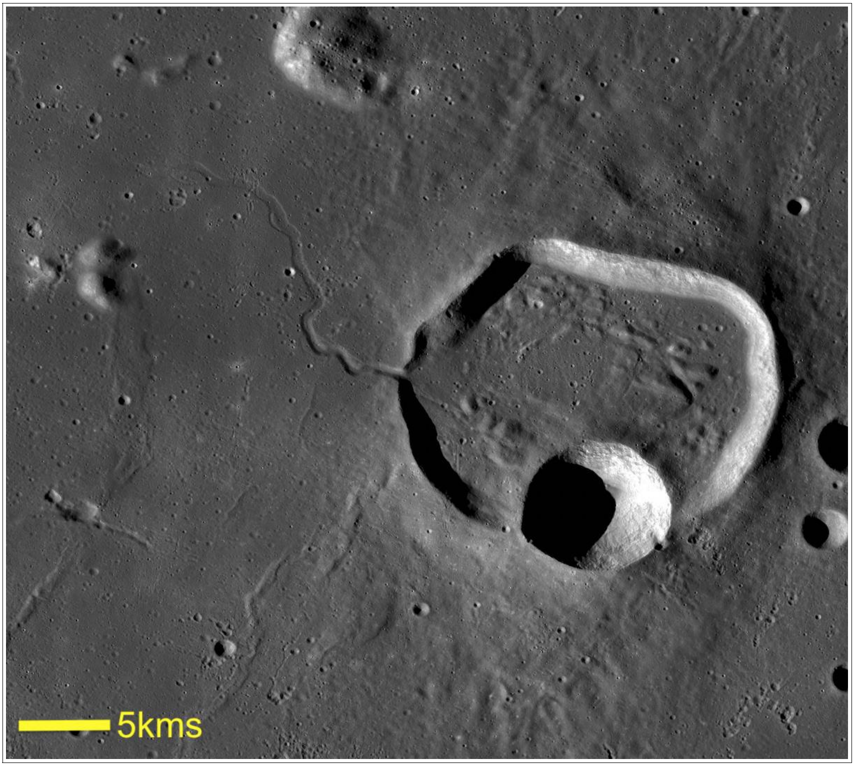

Fig.1. SELENE image of Krieger, showing the smaller crater Van Biesbroeck interrupting its southern rim and Rima Krieger crossing the western rim and petering out some 23kms away. The crater bears a passing resemblance to a microorganism with a whip like flagellum.

Fig.1 is an evening image from SELENE of Krieger, showing the younger Van Biesbroeck perched on its southern rim and Rima Krieger, which appears to be a sinuous rille cutting the western rim. What is immediately apparent is that Krieger is not circular in planform but has a somewhat 'squared off' appearance, with a an 11km section of its northern rim being quite straight. It is also slightly wider east-west measuring some 23kms compared to north-south which measures some 20kms, not a huge difference but enough to emphasize a slightly elongate shape along the former axis.

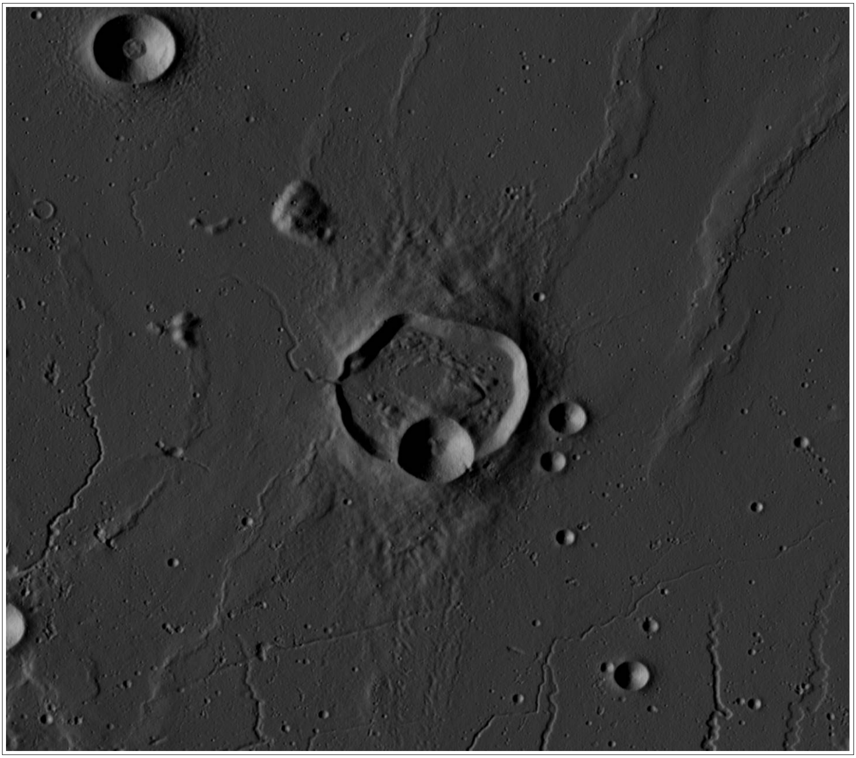

Fig.2. LRO Quickmap rendition of Krieger with the 'TerrainHillshade' layer enabled to give a shaded relief image which picks out fine detail in the topography. Note the converging crater chains to the south and the two triangular areas of ejecta just outside the northern rim. The crater Toscanelli is peeping out from the bottom left edge of the frame.

The clue to the origin of this unusual shape lies in the ejecta surrounding the crater, which is nicely visualised in Fig.2 which is a LRO Quickmap rendition with the 'TerrainHillshade' layer enabled, which picks out fine detail in the surface topography. As can be seen, the ejecta is concentrated into 'butterfly-wings' to the north and south, identifying it immediately as a low angle impact. The patterns are not quite symmetrical, to the south there is a converging stream of secondary crater chains, whilst to the north there are a pair of triangular dollops of proximal ejecta extending away from the northern rim, with a pronounced 'V' shaped feature between them, with the apex pointing back towards the rim. These *may* indicate that the crater was formed by more than a single impactor, with each component forming its own ejecta feature – similar to the ejecta features we saw in Schiller in last month's LSC[2]. In this case, the two triangles might suggest at least two impactors, but the complicated ejecta pattern might hide evidence of more than two separate impacts. Another example of this type of messy multiple impact can be seen in Adams B, which has an irregular outline and ejecta indicating multiple impactors arriving on a low angle trajectory[3].

There is little ejecta to the east of Krieger and a Zone of Avoidance (ZoA) to the west which is clearly seen to the north where the northern 'butterfly-wing' terminates in a conspicuous straight line orientated SE-NW. Interestingly enough, the nearby crater Gruithuisen appears to have been formed by a low angle impact from the same direction, and has a well preserved 'butterfly-wing-pattern ejecta similar to that seen in Krieger. Gruithuisen also shows another feature characteristic of low angle impacts, in that the up-range rim to the west (the rim on the side from which the impactor arrived) is lower than the down-range rim to the east (Fig.3). The same applies to Krieger, but whilst the difference in rim heights in Gruithuisen amounts to a modest 80m or so, in Krieger the height difference is more like 700m!

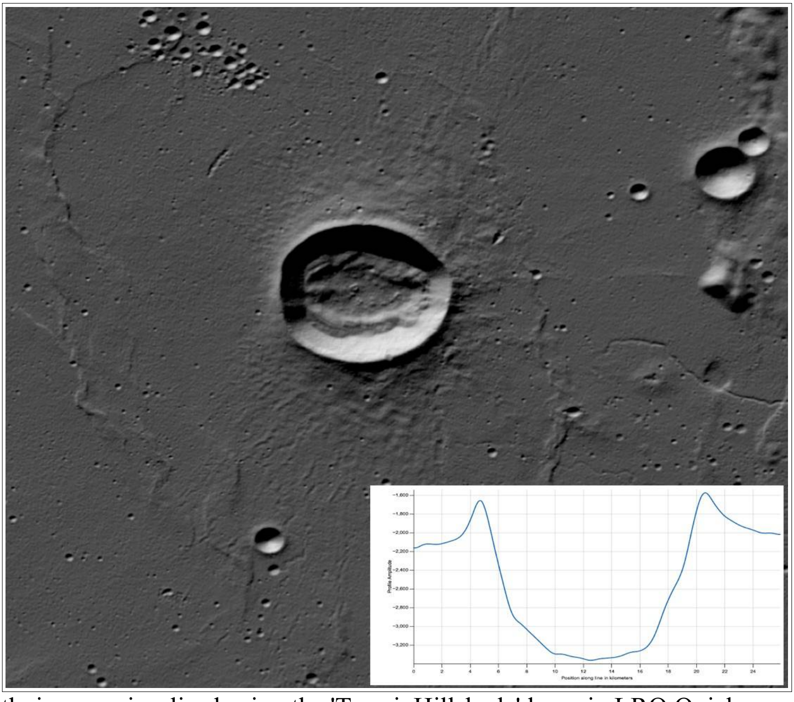

Fig.3. Gruithuisen as visualised using the 'TerrainHillshade' layer in LRO Quickmap. Note the elongate planform and butterfly-wings to the north and south. The inset shows the topographic profile along the long axis, showing the depressed western (up-range) rim.

This neatly explains the presence of Rima Krieger, as the lava flow that created it breached the crater rim at its lowest point which would correspond to mid point in the ZoA. Evidence of flowing lava is abundant in the area in the form of numerous sinuous rilles, most of which originate on the high ground of the Aristarchus plateau or to the NE of Prinz, and head downslope to the north. Rima Krieger is not however related to this swarm of rilles or mare lavas, but originates from within the crater itself. A scenario that would account for this would be that Krieger formed at a time when volcanic activity beneath the Aristarchus plateau was still in full swing, and eruptions of low viscosity lava were producing some of the numerous rilles in the area. The newly formed Krieger became a focus of some of this activity and it is possible that at some stage it went through a Floor Fracture Crater phase, with magma intruded beneath the crater floor, pushing it upwards by some 1000m, and then erupting *onto* the floor to fill the interior with molten mare type lavas. These lavas appear to be compositionally of a low titanium content, similar to those that dominate the surface of the Aristarchus plateau to the south

The level of this molten lava rose until it breached the the crater rim at the low point to the west, and began to flow out of the crater and onto the mare surface. The lava stream eroded a channel down through the rim as it flowed, and then eroded down into the pre-existing mare surface to form Rima Krieger. Today the channel through the western rim is perched some 80m above the crater floor, rather like one of the 'hanging valleys' seen in glacial landscapes. This shows that the level of molten lava within the crater must have been considerably higher at the time Rima Krieger formed, but that this level then dropped considerably, and at some point cut off the supply of lava flowing outwards onto the mare surface. So, despite looking like a sinuous rille, Rima Krieger is not an example of this type of feature, but a lava outflow channel, though the end result is pretty much the same. The rima is however quite short, extending for only some 24kms before it merges into the general mare surface. The reason for this is that beyond this distance the lava entered a broad saucer shaped depression, and ponded to form a lava lake.

Evidence for this can be seen by looking at the volcanic sinuous rille that originates in a pit just to the north of the crater Toscanelli (Fig.2). This rille flows north, following the regional slope for some 36kms before petering out and becoming invisible, and it does this as it enters the saucer shaped depression noted above. After a further 8kms it becomes visible again beyond the northern edge of the depression, continuing north for a further 16kms before disappearing for good just to the SE of Wollaston. Now, it is probable that at the time this rille formed there was no depression along its course, and it flowed uninterruptedly northwards to its terminus near Wollaston, as the low viscosity lavas would have ponded on entering the depression, and the northern section of the rille would not have formed. This suggests that the depression post-dates the rille, forming as a result of either tectonic or volcanic (or both) forces operating at the time. Krieger formed at a later date followed by the eruption of lavas within the crater itself. The lavas flowing out through Rima Krieger then encountered this depression and ponded to form a lava lake and drowned the section of the older 'Toscanelli' rille crossing it from south to north.

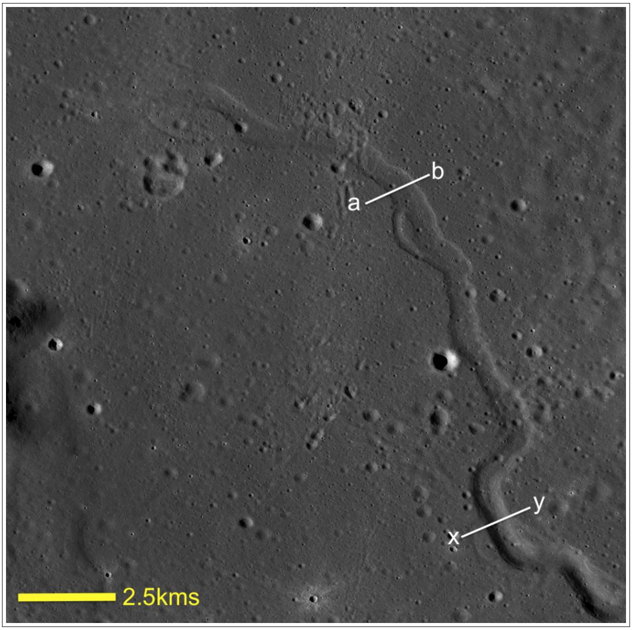

Fig.4. SELENE image of the distal part of Rima Krieger and its transition from a deeply incised channel some 50m deep (at x-y) to a broader shallower channel 25m deep (at a-b). The rille peters out towards the upper left where it enters the ponded depression.

This ponding would explain why the depth of Rima Krieger drops over a distance of only a few kilometres from ~50m down to ~ 25m (Fig.4) as the ponding lavas would have dramatically reduced the flow velocity as it backed up into the channel, drowning its lower reaches and reducing its ability to carve down into the mare surface. This ponding also caused the channel to widen as the stagnating lavas thermally eroded the banks on either side, which might also account for the lens shaped slumps of the banks visible at a few points along the rilles length.

Clearly volcanism was active throughout the period during which these features formed, but bearing in mind the location perched on the edge of the Aristarchus plateau, this is hardly surprising.

Barry Fitz-Gerald. (barryfitzgerald@hotmail.com)

Acknowledgements:

LROC images and data reproduced from Quickmap 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.jp

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1. Longshaw, N. Krieger, The man and his crater. Astronomy Now, December 2021.

2. Fitz-Gerald, B (2022). Schiller. BAA Lunar Section Circular, Vol.59, No.1

3. Fitz-Gerald, B (2013) Adams B, A possible hybrid crater. Selenology Today. No 31, http://www.lunar-captures.com//Selenology_Today/selenologytoday31.pdf

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Lunar Geological Change Detection Programme.
By Tony Cook.

TLP reports: No TLP reports have been received for December, though on 2021 Nov 20 UT 22:41-22:55 Trevor Smith (BAA) using a 16" reflector (Seeing: Antoniadi III-IV), found that there was a hint of red seen to the west of the ejecta field of Censorinus, but he comments that it was less noticeable than normal, perhaps because of the Moon's higher altitude that night. I guess that if one is going to see a hint of atmospheric spectral dispersion then it would be more noticeable on bright contrasty craters, such as Censorinus. He did not notice any atmospheric spectral dispersion elsewhere and no blue on the opposite side ejecta blanket, but that could be a contrast effect from Rayleigh scattering in our atmosphere at short optical wavelengths.

Routine Reports received for November included: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Archimedes, Aristarchus, Grimaldi, Langrenus, Mons La Hire, the lunar north polar region, Plato, Torricelli B and imaged several other features. Peter Anderson (Australia – BAA) imaged the lunar eclipse. Massimo Alessandro Bianchi (Italy – UAI) imaged: Rima Hadley. Rodrigo de Brix (Argentina – SLA) imaged: the lunar eclipse. Luis Francisco Alsina Cardinalli (Argentina – SLA) imaged: the lunar eclipse. Jorge Coghlan (Argentina – SLA) imaged: the lunar eclipse. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Arago, earthshine, the lunar eclipse, Theophilus, and the whole lunar disk. Walter Elias (Argentina – AEA) imaged: Alphonsus, Aristarchus, Atlas, Cleomedes, Dionysius, Endymion, Eratosthenes, Furnerius, Gassendi, Grimaldi, Harden, Langrenus, Mare Crisium, Mare Frigoris, Mare Tranquillitatis, Messier, Plato, Romer, Stofler, Tycho, and Vieta. Valerio Fontani (Italy – UAI) imaged: Aristarchus and Rima Hadley. Les Fry (West Wales – NAS) imaged: Cleomedes, Democritus, Endymion, Langrenus, Mare Crisium, Petavius, Taruntius, Vallis Rheita, Vendelinus, and Vlacq. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Albategnius, the lunar eclipse, and Ptolemeaus. Daniel Mendicini (Argentina – SLA) imaged: the lunar eclipse. Leandro Sid (Argentina – AEA) imaged: the Moon, Plato and Sinus Iridum. Trevor Smith (Codnor, UK – BAA) observed: several features including Censorinus and Proclus. Franco Taccogna (Italy – UAI) imaged: Tycho. Aldo Tonon (UAI) imaged: Rima Hadley.

Routine Reports received for December included: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Aristarchus, Cassini, Eudoxus, and several features. Massimo Alessandro Bianchi (Italy – UAI) imaged: Eudoxus, Mersenius C and Tycho. Anthony Cook (Mundesley, UK – ALPO/BAA) imaged several features. Walter Elias (Argentina – AEA) imaged: Aristarchus, Atlas, Hecataeus, Mare Crisium, Mare Humorum, Plinius, and Theophilus. Valerio Fontani (Italy – UAI) imaged: Eratosthenes, Sinus Iridum, and the Full Moon. Les Fry (West Wales – NAS) imaged: Bailly, Copernicus, Grimaldi, Inghirami, Lacus Aestatis, Mairan, Mare Smythii, Pythagoras, Vieta and Yakovkin. Rik

Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Mare Crisium, Arzachel, and Montes Apenninus. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Censorinus, Linne, Menelaus, Plato, Ross D, and several features. Franco Taccogna (Italy – UAI) imaged: the Full Moon. Aldo Tonon (UAI) imaged: Eudoxus and the Full Moon. Luigi Zanatta (Italy – UAI) imaged Eudoxus.

Routine Reports Received:

Helicon: On 2021 Nov 10 UT 00:34-00:37 Maurice Collins imaged the Moon under similar illumination and topographic libration (both to within ±1.0°) of the following report:

Helicon Bright spot seen. 1787 May 22 UT 21:00 (estimated) by M. de Villeneuvre. The Cameron 1978 catalog gives this TLP an ID No. of 36 and a weight of 1. The ALPO/BAA catalog weight is also 1.

Figure 1. Part of a whole Moon image obtained by Maurice Collins (ALPO/BAA/RASNZ) on 2021 Nov 10 UT 00:34-00:37 and orientated with north towards the top.

Although it is debatable whether Fig 1 reaches far enough west to cover the region on the Moon where Helicon would be, it emphasizes the fact that de Villeneuvre must have been observing this in earthshine. The 1887 May 22 TLP in the normally uninteresting crater Helicon (SE of Sinus Iridum), comes at a time when there was a spate of reports of lunar volcanos being seen in earthshine that year according to p64 of George G. Carey's book: "Astronomy, as it is Known at the Present Day: With an Account of the Nature…". The most notable of these was "Herschel's Volcano" on 19th April, though some regard that he may have mistaken Aristarchus, Copernicus and Kepler ray craters as volcanos – but the resemblance of the brighter one of these (Aristarchus?) *to "a small burning piece of charcoal, when it is covered by a thin coat of white ash"* has always puzzled me as Aristarchus generally does not exhibit colour in earthshine. Anyway, whatever de Villeneuvre saw near Helicon, (technically speaking 3 minutes of arc from the edge of the Moon, towards the spot called Helicon) remains a mystery, though there is a bright small ray crater Laplace A that might show up in earthshine? Laplace A is only 8 km in diameter and fairly point-like so would appear at its brightest when seeing conditions were good. Helicon has featured in two other TLP reports: 1788 Mar 13 (earthshine) and 1979 Aug 7 (day side – but probably normal appearance).

Tycho: On 2021 Nov 14 Franco Taccogna (UAI) imaged this crater in red, green and blue filters under similar illumination to the following report:

Tycho 1998 Feb 06 UT 22:48-22:54 R. Braga (Corsica (MI), Italy, 102mm f8.8 refractor, x180, with diagonal, Wratten 23A, 80A and an OR5 filter, seeing II, Transparency good). Observer noticed that the floor darkened towards the NW (IAU), particularly with the blue Wratten 80A filter. The ALPO/BAA weight=2.

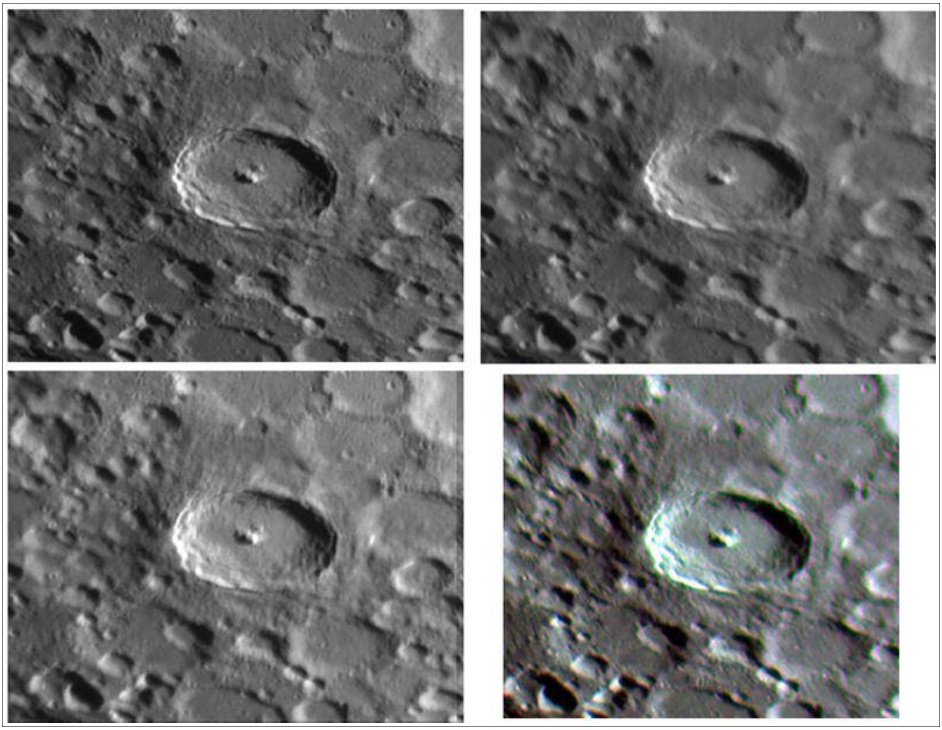


Figure 2. Tycho as imaged by Franco Taccogna on 2021 Nov 20 and orientated with north towards the top. (Top Left) Red filter image captured at UT 16:53. (Top Right) Green filter image captured at UT 16:55. (Bottom Left) Blue filter image captured at UT 16:56. (Bottom Right) Combined RGB image that has been colour normalized and then under gone a colour saturation increase of 60%.

Any colour visible to human eyes should become very apparent on filter CCD images. The individual RGB images in Fig 2 (Top Left, Top Right, and Bottom Left) ought to show the NW corner of the floor brighter in the red and possibly green filters and/or darker in the blue filter. However, there is no sign of this. Even in a colour enhanced version (Bottom Right) there is no obvious colour on the NW floor. Therefore, whatever was seen back in 1998 was either lunar in origin or related to the local observing conditions/optics – however the use of filters should have precluded this possibility of it being due to atmospheric spectral dispersion or chromatic aberration. If you blur your eyes when looking at Fig 2, you may see a hint of darkening in the NW quadrant of the floor. We have examined repeat illumination observations of this TLP report before in the 2017 Nov (p26) and 2020 Dec newsletters. Back in 2017 Sep Jay Albert did detect some darkening on the NW floor in blue light visually, but this P59-60) was not confirmed by a camera phone image. On 2020 Oct 20 Daryl Dobbs observed a similar visual effect. I think we will lower the weight to 1 as something is triggering a visual perception of colour on the NW quadrant, but so far nothing has been detected with colour imagery.

Plato: On 2021 Nov 14/15 UT Leandro Sid and Walter Elias (AEA) imaged this crater under similar illumination to the following report:

Plato 1998 Mar 08 UT 19:30-20:10 S. Beaumont (Windermere, UK, 30cm reflector, Meade 23A and 38A filters, seeing III, transparency fairly good, some haze) observed a whitish misty effect seen bordering the shadows of the SE rim. It appeared intermittently and was not seen in the violet or red filters. Observer wonders if it could have been an effect associated with the Earth's atmosphere, which was unsteady with some haze. However, other craters appeared normal. The ALPO/BAA weight=1.

It turns out that the Ron Livesey (BAA) was observing just 5 min after Sally finished her observation and saw nothing unusual. Compare Fig 3 (Top Left and Top Center). Leandro’s image (Fig 3 – Top Right) also shows nothing unusual although pretty much all of the floor is featureless. Two of the lower images (Fig 3 Bottom Left, Bottom Center) are all from our archive and show an inner narrow white boundary between the SE shadow and the floor, under similarly the same illumination to Sally’ sketch. A central craterlet us just visible as a light spot. Franco and Maurice’s images though do have part of the lowest part of the crater rim making it into sunlight on the south east, possibly wall slump/inner terrace? Once we get to Walter’s image (Fig 3 – Bottom Right) we see that the shadow has receded a bit further inside the SE rim and more of the inner terrace/wall slump is visible and begins to look a little like what Sally drew back in 1998. But then why did Ron not see a simar effect? Most likely because his scope was smaller and he was concentrating more on the brightest parts of the crater. I think we can now safely remove Salley’s 1998 observation from the TLP database by assigning a weight of 0

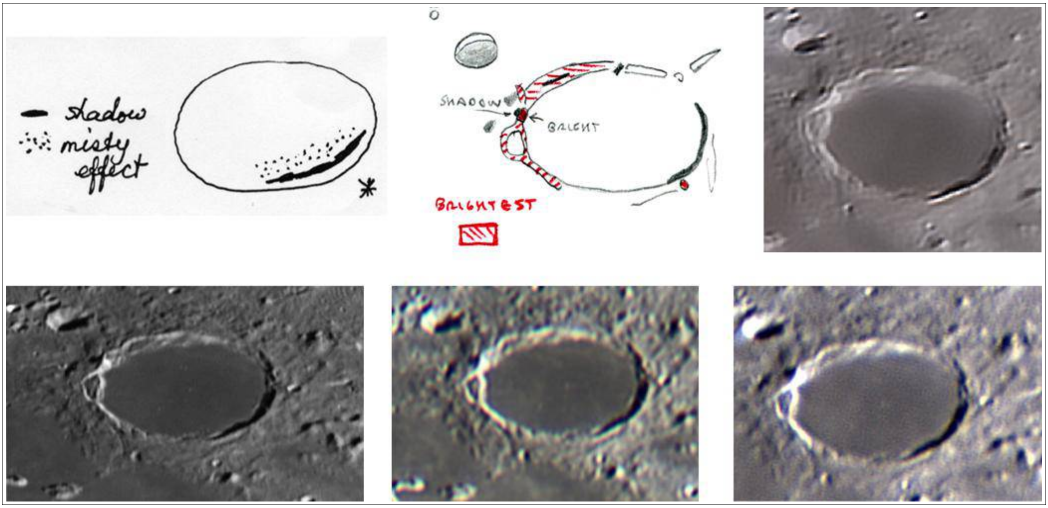


Figure 3. Plato, orientated with north towards the top. (Top Left) A sketch by Sally Beaumont (ALPO) made on 1998 Mar 08 UT 19:30-20:10. (Top Center) A sketch by Ron Livesey (BAA) made on 1998 Mar 08 UT 20:15 – note the red ink denotes the brightest parts of the crater and not colour. "65 Spec", x133, seeing 3. Annotation has been rotated and moved. (Top Right) Image by Leandro Sid (AEA) taken on 2021 Nov 14 UT 23:52. (Bottom Left) An image by Franco Taccogna (UAI) taken on 2018 Jun 23 UT 21:39. (Bottom Center) A colour image taken by Maurice Collins(ALPO/BAA/RASNZ) on 2018 Sep 20 UT 07:33. (Bottom Right) A image taken by Walter Elias (AEA) on 2021Nov 15 UT 00:58.

Torricelli B: On 2021 Nov 16 UT 02:26-02:46 Jay Albert observed this crater under similar illumination to the following report:

Torricelli B 1995 Apr 11 UTC 20:15 Observed by North (UK). "Colour moon blink reaction, and crater dull". The Moon was at about 39° in altitude at the time. BAA Lunar Section report. ALP\BAA weight=3.

Jay used a Celestron NexStar Evolution 8" SCT, x226 an x290. His sky was partly cloudy and hazier than the previous night. Transparency was 1st magnitude and seeing was initially 7/10. The crater was dull, as described in the TLP listing. He compared the view in the Wratten 25 red and 44A blue filters with inconclusive results. However, as the haze increased, he thought the view in the red filter may have been a little enhanced compared with the blue.

We have received repeat illumination observations before i.e., in the 2019 Mar newsletter (p23-24), where Franco Taccogna (UAI) sent in some images. I showed these to Gerald North and he replied with the following back in 2019 Jan:

. . . . .”I observed between 19h 16m and 20h 55m UT using my 464 mm Newtonian reflector. I recorded the conditions as: " ANT. IV/V. Transparency poor, due to heavy haze and slight fog. At first, I thought that Torricelli B looked a little prominent in a low power (X104) eyepiece. That was the first night of using that particular eyepiece (a 25 Kellner, given to me with other parts of Bill Peter's telescope, by Bill's widow and son). Then I examined it at X144 and X207 (my 18mm and 12.5 mm Orthoscopic eyepieces and decided that Torricelli B was normal after all. Then I tried green and deep red colour filters. I found Torricelli B appeared very dull - in fact very hard to see - in the deep red filter. . . . . (But I am sure that I would not have suspected it as any genuine TLP, just an interesting effect).

The following night I found the same thing through the red and green filters. Normal through green, extremely dull through deep red. (Same telescope; ANT. V. Transparency fair).

My overall conclusion was that all was normal with Torricelli B (and everything else of the Moon) at the time of observation on 11th and 12th April 1995.”

So, the dull nature is perfectly normal, and the fact that he saw the same effect the next night does imply it was not an TLP. Note that hazy conditions prevailed in both of the observations by Gerald and also the more recent one by Jay, though interestingly Jay found the crater a little “enhanced” in red light than in “blue” i.e., the opposite. I am interested in why people sometimes see colours, so will remove this from the TLP database, but will put it onto the Lunar Schedule web site with specific instructions not to observe unless there is haze present above the observing site.

Aristarchus: On 2021 Nov 17 Valerio Fontani (UAI) imaged this crater under similar illumination and topocentric libration (both within ±1.0°) to the following report:

Aristarchus 1975 May 23 P.W. Foley (Wilmington, UK, 12" reflector, x200, x360, x624, atmospheric clarity good, seeing III from 20:15-22:30, but then clouded out at 22:30, and from 23:15-01:15 seeing was IV-V with poor transparency) observed (22:20-20:45 UT) variation in the SE corner of the Aristarchus, namely the usual dark bands were alternating light to dark, not in keeping with other crater features. This effect was not linked to atmospheric turbulence. Also projected image of bands beyond the crater W. wall were repeatedly noted. The observer broke away from observing at 20:45UT to make a telephone alert call. At 20:55UT they noted that the area between Vallis Schroteri and Herodotus seemed very light/bright, also the E. exterior of the crater wall of Herodotus. From 21:01-21:11 A slight blueness was seen to extend from the NE corner of Aristarchus, along the exterior rim, across and beyond Herodotus to the SW. A thorough search was made of many bright areas, both near the terminator and to the E., but no blueness could be detected elsewhere. A slight orange hue was noted along *the E. limb of the Moon (Spurious colour). From 21:18;22:30 Aristarchus seemed normal again, and likewise the head of Vallis Schroteri too. The observer was clouded out from 22:30-23:15 and from 23:15-01:30 the seeing was so appalling that no colour or projection of the bands could be seen. A Moon Blink was used during the session, but no colour was detected in this? Another observer, R.W. Rose (Devon, UK) observed 21:20-21:30 but had IV seeing, and saw nothing unusual, but commented that if TLP activity had been taking place, then they would probably not have seen it anyway. The ALPO/BAA weight=1.*

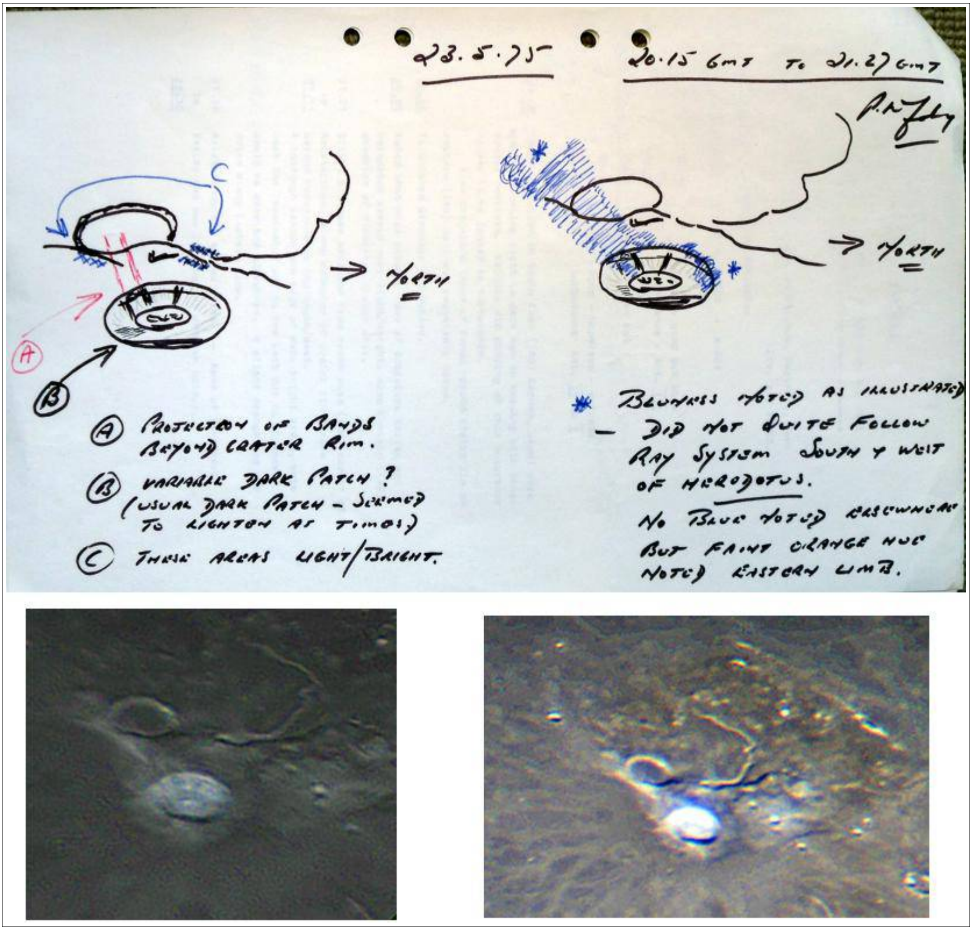


Figure 4. Aristarchus orientated with north towards the right. (Top) A couple of sketches made by Peter Foley form 1975 for the date and UT range given at the top of the page. (Bottom Left) A colour image by Valerio Fontani taken on 2021 Nov 17 UT 18:58. The colour saturation has been increased to 70%. (Bottom Right) A colour image by Maurice Collins taken on 2015 Jul 29 UT UT08:38-08:29 with colour saturation increased to 60%.

Valerio Fontani's image (Fig 4 – Bottom Left) is unique in that it is what Aristarchus would have normally looked like on the night that Peter Foley observed to within ±1.0° similar illumination and also topocentric libration (viewing angle). The image is slightly under exposed, but clearly shows what Foley refers to as an extension of the SW interior dark bands of Aristarchus, beyond the rim and out onto the outside – see "A" in Fig 4 (Top). Likewise, what Foley marks as "C" or light/bright areas are visible too. Peter Foley's "B" area is a mixture of detail in Valerio's image, so is not surprising it will vary under poor seeing conditions. As to the blueness depicted in Fig 4 (Top) sketches, we can see some of this around the north rim of the crater in Maurice Collins similar illumination sketch (Fig 4 – Bottom Right). What is puzzling though is the large area of blueness that Foley draws over the ray and beyond its boundary. I think we need to leave the weight at 1 for now but refocus the description onto the extent of the blueness seen.

Partial Lunar Eclipse – 2021 Nov 21: Images were received from: SLA observers: Rodrigo de Brix, Luis Francisco Alsina Cardinalli, Jorge Coghlan, Daniel Mendicini, Peter Anderson (BAA), Maurice Collins (ALPO/BAA/RASNZ) and Rik Hill (ALPO/BAA). As eclipse go this was nearly, but not quite total, and observing conditions were not great for most observers.

SLA observers, operating from Sante Fe, Argentina, secured pre-eclipse images prior to first contact of the Penumbra at 06:02, which are effectively images of the Full Moon. This is useful for our project to study the relative brightness of features around Full Moon time. Measurements of digital number brightness sorted from dark to bright were found to be:

Plato (144), Kepler (186), Copernicus (198), Aristarchus (129), Tycho (129), Censorinus (216), Proclus (222) and the bright patch near Hell (225).

A slightly unusual appearance was seen on the edge of the shadow in an image (Fig 5) by Maurice Collins which looks like a nick in the edge of the umbra, but it is only the high albedo crater Aristarchus emerging from the shadow and the contrast stretched image makes it look like an indent.

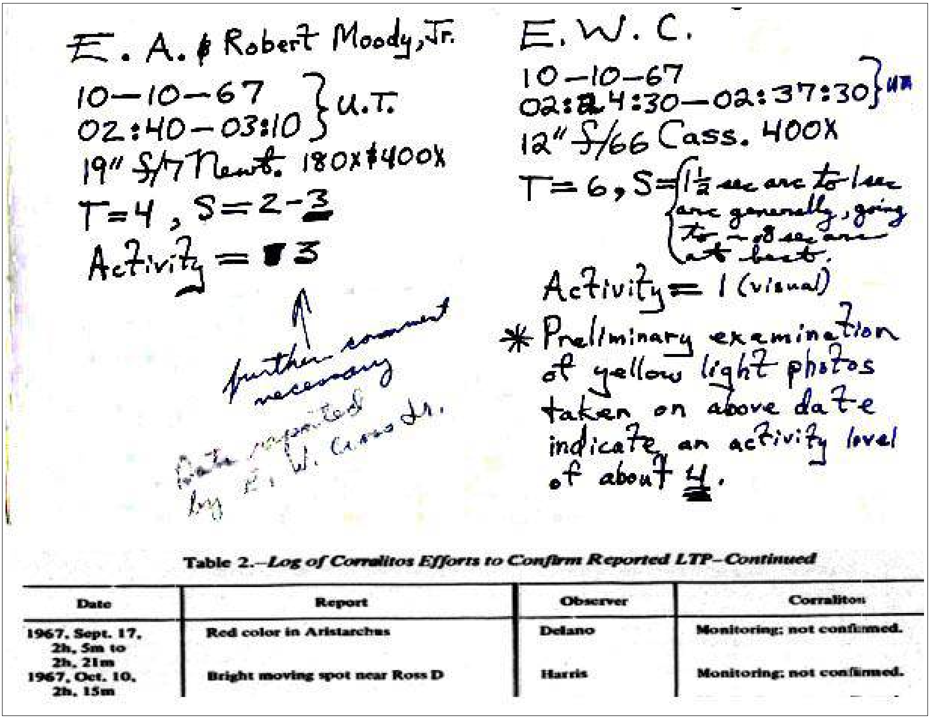
Figure 5. The partial lunar eclipse of 2021 Nov 19 UT 09:51 taken by Maurice Collins (ALPO/BAA/RASNZ) and orientated with north towards the top. Note the nick in the shadow edge effect due to Aristarchus.

Ross D: On 2021 Dec 10 Trevor Smith (BAA) brought the power of his 16” Newtonian onto this small 9 km diameter crater, which was a subject of a TLP event back in 1867 (under similar illumination):

SE of Ross D 1967 Oct 10 UT 02:25-03:10 Observers: Daniel Harris (Tucson, AZ?) Corralitos Obs (Organ Pass, NM, USA, 24" reflector) "Bright area moved 80km/hr towards SSE & expanded as contrast reduced. Corralitos MB did not confirm" NASA catalog weight=3. NASA catalog ID #1049. Reports in ALPO/BAA archive mention observations from Edmund Arriola & Robert Moody, Jr. 02:40-03:10 (19" Whittier College, x170 & x400, T=4, S=2-3) & Cross 02:25-02:38 (12" f/66 Cass, x400, T=6, S=1.5 to 1") - the latter although seeing low visual activity, apparently according to Harris, took some yellow light photos that showed high activity? ALPO/BAA weight=2.

There have been numerous reports of TLP in Ross D, and I enclose some reports from the event in question in Fig 6. We do not appear to have anything from Daniel Harris or Edmund Arriola – as the Cameron catalog states, nor any photos in our archives. This is rather unfortunate. However, we do have Trevor Smith’s modern report of what the crater normally looks like at this stage in illumination – though his seeing was Antoniadi IV-V:

Trevor observed from 17:00-17:20 and 17:40-17:50 on 2021 Dec 10. He saw a bright fuzzy patch to the NE of Ross D at a distance of about 25 km (a normal permanent feature). There was no moving bright patch seen at all (unsurprisingly) however under some fleeting moments of better seeing conditions, he did notice a greyish/white streak or ray, that just happened to lie in the SSE direction.


E. A. & Robert Moody, Jr.
10-10-67
02:40-03:10 } U.T.
19" f/7 Newt. 180X & 400X
T=4, S=2-3
Activity = 3
further comment necessary
Data reported by E. W. Cross Jr.

E. W. C.
10-10-67
02:34:30-02:37:30 } UT
12" f/66 Cass. 400X
T=6, S= { 1½ sec arc to less arc generally, going to ~.8 sec arc at best.
Activity = 1 (visual)
* Preliminary examination of yellow light photos taken on above date indicate an activity level of about 4.

Table 2.—*Log of Corralitos Efforts to Confirm Reported LTP—Continued*

Date	Report	Observer	Corralitos
1967, Sept. 17, 2h, 5m to 2h, 21m	Red color in Aristarchus	Delano	Monitoring: not confirmed.
1967, Oct. 10, 2h, 15m	Bright moving spot near Ross D	Harris	Monitoring: not confirmed.

Figure 6. Some Ross D observation from 1967 Oct 10. (Top Left) from E.A. Robert Moody Jr. (Top Right) from Eugene W. Cross. (Bottom) A negative report from Alan Hynek’s group at the Corralitos Observatory, NM, USA.

This of course did not move but Trevor considers the possibility that under the right conditions, during all but brief perfect moments of seeing it might trick the eye/brain into thinking some movement was present? He also saw a lone mountain some 25 km away from the crater, but also in the SSE direction.

It is interesting to note that the Corralitos team, observing on the same night on 1967 Oct 10 at 02:15 UT did not detect any colour blinks, however the event in question was not colour but movement, and Corralitos were observing 10 min prior to the start of the TLP. However, I am also not sure what the Moody and Cross reports mean by “activity levels”?

We shall leave the ALPO/BAA weight at 2 for now.

Eudoxus: On 2021 Dec 11 Italian UAI observers: Massimo Alessandro Bianchi, Alodo Tonon, Luigi Zanatta and in the Florida, USA ALPO observer Jay Albert - observed this crater under the following lunar schedule request and repeat Illuminations predictions – respectively:

BAA Request: Eudoxus - please try to image the interior of this crater. We are trying to detect bright spots and a linear features within the shadow of the east wall at sunrise. Nigel Longshaw (BAA) suspects that this might explain Trouvelot's observation in 1877 of a luminous rope-like feature. For selenographic colongitudes of between 0.2° to 1.2°.

"Eudoxus" 1877 Feb 20 UT 21:30-22:30 Observed by Trouvelot (Meudon, France, 13" refractor?) "Fine line of light like a luminous cable, drawn W. to E. across crater". NASA catalog weight=1. NASA catalog ID #185. ALPO/BAA weight=1. Within ±0.5° similar illumination to the observing times given for Trouvelot.

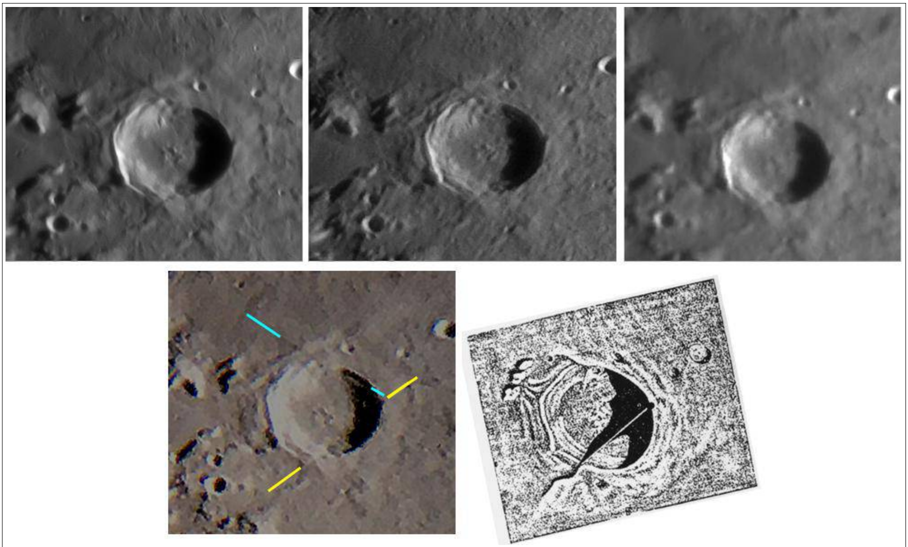


Figure 7. Eudoxus, orientated with north towards the top. (Top Left) 2021 Dec 11 UT 16:30 as imaged by Massimo Alessandro Bianchi (UAI). (Top Centre) 2021 Dec 11 UT 17:20 as imaged by Aldo Tonon (UAI). (Top Right) 2021 Dec 11 UT 17:31 as imaged by Luigi Zanatta (UAI). (Bottom Left) An iPhone image obtained by Jay Albert on UT 01:26. Arrows indicate two possible lineaments. (Bottom Right) A sketch by Trouvelot from a letter by Nigel Longshaw to the BAA Journal from 2007 Vol 117, No. 6, p344.

Fig 7 Top left to Top Right were taken under similar colongitudes to Trouvelot's report (Fig 7 – Bottom Right), but fail to show what Trouvelot reported. This might infer that the time given by Trouvelot may not have been 21:30-22:30 UT 1877 Feb 20. Jay, observing later, commented that he saw considerable shadow on the interior E wall and floor. Two points of light were seen within the shadow where higher elevations were touched by sunlight. A slim line of light running roughly N to S was also seen within the E wall shadow just north of the two points and parallel to the E wall. This appeared to be a lower slope or terrace of the E wall. No “fine line of light like a luminous cable…” was visible going E-W across the crater. He used a Celestron NexStar Evolution 8” SCT at x290 and observed visually from 00:30 to 00:50UT on 2021 Dec 12. He took an image later, which shows some of these features, as can be seen in Fig 7 (Bottom Left). Arrows have been used to highlight similarities between the Trouvelot sketch and Jay’s image. The yellow tick marks refer to a lineament effect that Nigel Longshaw has noted before. The blue/green arrows in Fig 7 (Bottom left) refer to another lineament effect not shown in Trouvelot’s sketch. We shall keep the weight of the 1877 TLP report at 1 as I do not fully understand the weird shadow shape associated with the southern crater crossing lineament.

Full Moon Crater Brightness: Italian UAI observers: Valerio Fontani, Franco Taccogna, and Aldo Tonon have submitted images of the lunar disk, close to Full Moon. We are interested in these as there have been many past TLP reports, as measured with visual photometric devices (Crater Extinction Devices or C.E.D.s) that suggested that some craters were sometimes brighter than they normally were at a particular colongitude. By observing close to Full Moon time, the relative brightness of some key craters are related to their albedo, and so should not change unless due to slight differences in illumination and more particular viewing angles (topocentric libration). We shall make a full study of this in due course, but for now will note the relative brightness order of the craters, as is shown in Table 1.

	Fontani 2021Dec18 21:32UT	Tonon 2021Dec18 21:52UT	Taccogna 2021Dec19 18:14:UT
Aristarchus	185	190	188
Censorinus	252	220	236
Copernicus	146	165	156
Kepler	129	160	145
Plato	63	92	78
Proclus	252	205	229
Tycho	163	188	176
Bright Spot near Hell	207	201	204

Table 1. Digital Number brightness of different craters

So, on 2021 Dec 18 Valerio Fontani’s results, from dark to bright, go: Plato, Kepler, Copernicus, Tycho, Aristarchus, bright spot near Hell, Censorinus=Proclus. Also, Tonon’s results go: Plato, Kepler, Copernicus, Tycho, Aristarchus, bright spot near Hell, Proclus, Censorinus. So, the order is the same apart from Proclus and Censorinus changing places – easily explained due to difficulties in finding the representative brightest parts on these relatively small features. Interestingly on the following day, the order is again: Plato, Kepler, Copernicus, Tycho, Aristarchus, bright spot near Hell, Proclus and Censorinus.

Copernicus: On 2021 Dec 20 Walter Elias (AEA) imaged the region around this crater under similar illumination to the following report:

On 1978 Apr 23 at UT20:35 (Rawlings, UK, finderscope, x50) observed a bright flash (~0.3 sec duration) near to Copernicus (20W, 9N) with rays to the south east whilst he looked through a finder scope. Moore, who studied the drawing, suggests that the area of the flash was near Copernicus. However, Cameron says this cannot be the case if the flash was in darkness as mentioned in the BAA Lunar Section circular. She comments that it might have been a meteor? The Cameron 2005 catalog ID=28 and weight=1. The ALPO/BAA weight=1.

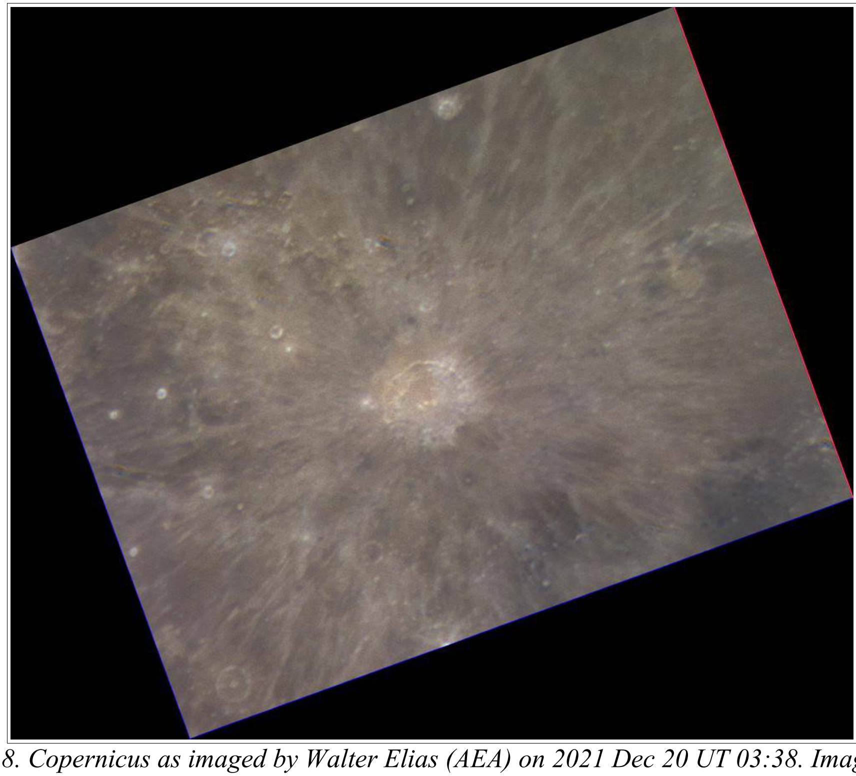


Figure 8. Copernicus as imaged by Walter Elias (AEA) on 2021 Dec 20 UT 03:38. Image has been rotated/flipped so that north was towards the top and west is on the right. The image has undergone a colour saturation increase of 75%.

Fig 8 shows that Copernicus would have been very much fully illuminated. I have checked the BAA Lunar Section circular from 1978 Jun, p47 and 48, and nowhere does it suggest that the flash was seen on the night side of the Moon, and it is not clear whether the rays referred to came from the flash or were rays from a crater on the Moon For a meteorite impact to be visible in a small power finder scope it would have to be quite bright, possibly 2nd or 3rd magnitude or brighter to be seen against the bright Moon. Such bright impacts tend to be of longer duration. If it had been a cosmic ray event then the duration would have been an instant flash. One other possibility was that maybe it was a strobe light from an aircraft passing through the field of view –at such a low altitude the plane would have been quite small, slow moving, and at low magnification the observer may not have seen the plane itself. I think this had better stay at a weight of 1 as it was an unconfirmed report.

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

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