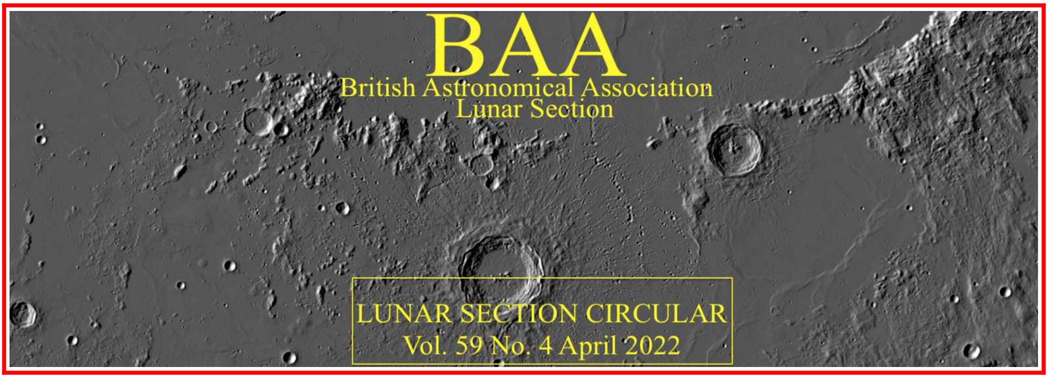

Editorial.
By Tony Cook.

The run up to the return of human exploration of the Moon has a very different feel to the Apollo programme from the late 1960's / early 1970's. There is certainly a lot less media excitement at the moment – perhaps because of the extensive news coverage of the pandemic and the invasion of the Ukraine. The test launch of NASA's Artemis 1 unmanned mission has been put off till June (possibly later), though it has at least been wheeled out to the launch pad for a dress rehearsal.

Similarly, Elon Musk's Starship, a variant of which will form the landing system for any future astronauts is also scheduled for a test launch sometime this Summer, but initially just an orbital flight around the Earth. One good point is that the missions are not being rushed, unlike the Soviet-US space race of the 1960's, so hopefully there will be less chance of things going wrong. We will keep you informed of any future developments, especially if it is possible to see some of these flights to the Moon through a telescope.

In this issue we have some good examples of what can be achieved by sketching the Moon as well as a couple of colour enhanced views of the lunar nearside.

Just a reminder again, if you haven't already booked your free slot at the Lunar Section meeting, down in Winchester, please do so as soon as possible. It will be held on Saturday 9th April. It can be booked through the BAA website: https://britastro.org/winchester2022 .

	Lunar Section Meeting
14:15 – 14:30	**Overview of the BAA Lunar Section's Activities** ***Dr Tony Cook (Lunar Section Acting Director)***
14:30 – 15:00	**Lunar Impact Flashes and How to Observe Them** ***Dr Tony Cook***
15:00 – 15:30	**Lunar Geology - Old Lunar Questions Revisited?** ***Barry Fitz Gerald (Lunar Circulars Editor)***
15:30 – 16:00	**Tea break**
16:00 – 16:30	**Lunar Occultations from a Personal Perspective** ***Tim Haymes (Lunar Occultations Coordinator)***
16:30 – 17:00	**New Space Missions and the Prospect for Future Low Cost Lunar Exploration** ***Nick James***
17:00 – 17:15	**Question Panel Session**

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Communications Recieved.

Interesting Lunar Weblinks:

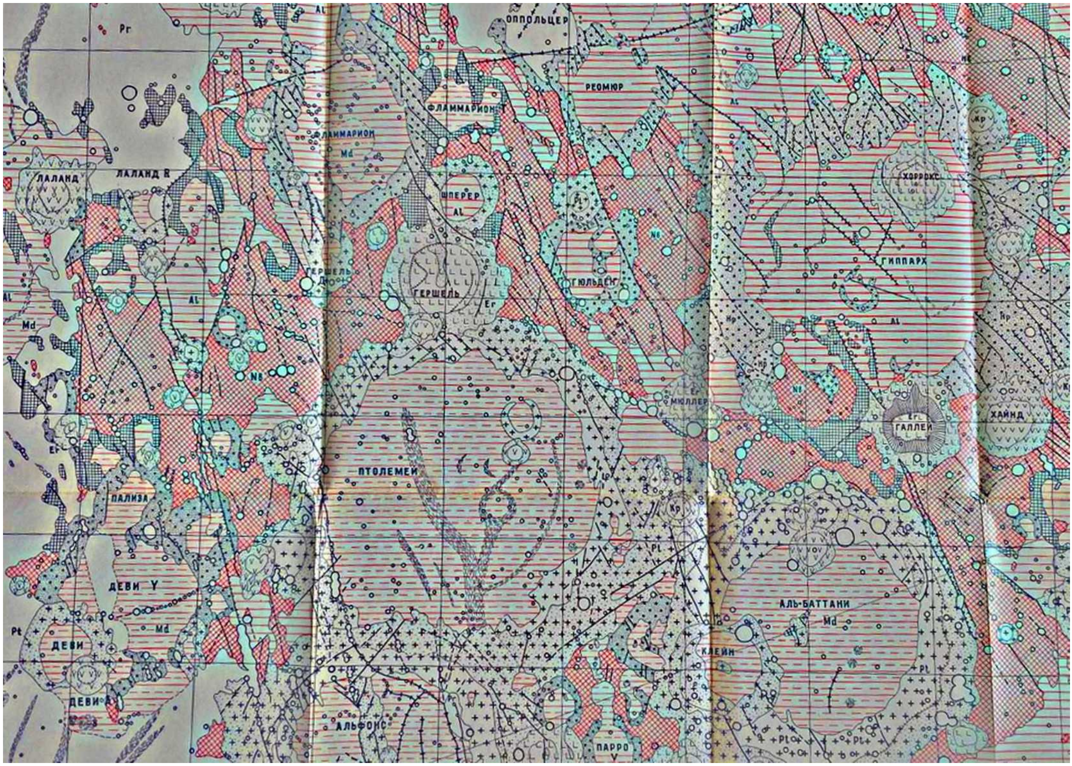
Kris Fry, from the Newtown Astronomy Society, emailed a couple of links that might be of interest to Lunar Section Members:

Firstly https://apod.nasa.gov/apod/ap220215.html is a full disk mosaic image of the Moon but generated by Jai and Neil Shet so that everywhere you look, you see a near-terminator view of the surface. It is made from 29 near terminator segments that have been mosaiced together.

Secondly, someone has tried out a 100 mega pixel camera on the Moon - https://photographingspace.com/100-megapixel-moon/, though to be honest this circular often contains images that surpass the zoomed in resolution of the Fujifilm GFX100 DSLR camera. The advantage of this camera though is you get everything at once.

Cartographic Additions to the Lunar Section Archives.

James Dawson had very kindly offered to donate some 1960's Soviet Lunar Geomorphological maps to the lunar section, including a Russian Atlas of the Lunar Farside (Lunik III observations, 1959). Although these have been surpassed by more modern geological maps by the USGS such as the "New Comprehensive Geological Map of the Moon", and NASA's LROC Quickmap web site, they are an interesting historical item, showing what east European interpretations of lunar geomorphology and geology were like in the 1960's.



A Soviet Geomorphological Maps of the region around Ptolemaeus crater

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OBSERVATIONS RECEIVED.

Observations have been received from the following:
Mário Roi Abade (Portugal), Paul Abel (UK), Leo Aerts (Belgium), David Finnigan (UK), Valerio Fontani (Italy), Rik Hill (USA), Bill Leatherbarrow (UK), Lars Lindhard (Denmark), Rod Lyon (UK), K.C. Paul (Hong Kong), Trevor Smith (UK), Bob Stuart (UK), and Peter Tickner (UK).

TARUNTIUS.
By Dr Paul Abel.

Taruntius is a 56 km diameter circular floor fractured crater in the Mare Fecundiatus, SW of Mare Crisium. Paul comments that: *"Taruntius crater was right on the terminator tonight. Alas seeing was only around AIII-IV and towards the end of the observation there were frequent passing clouds. Cameron crater which lies on the NW* *limb was largely in shadow. The central peak/hill in Taruntius was casting quite a splendid shadow onto the crater floor. Interestingly, just east of the central mound some darker sections could just be made out."*

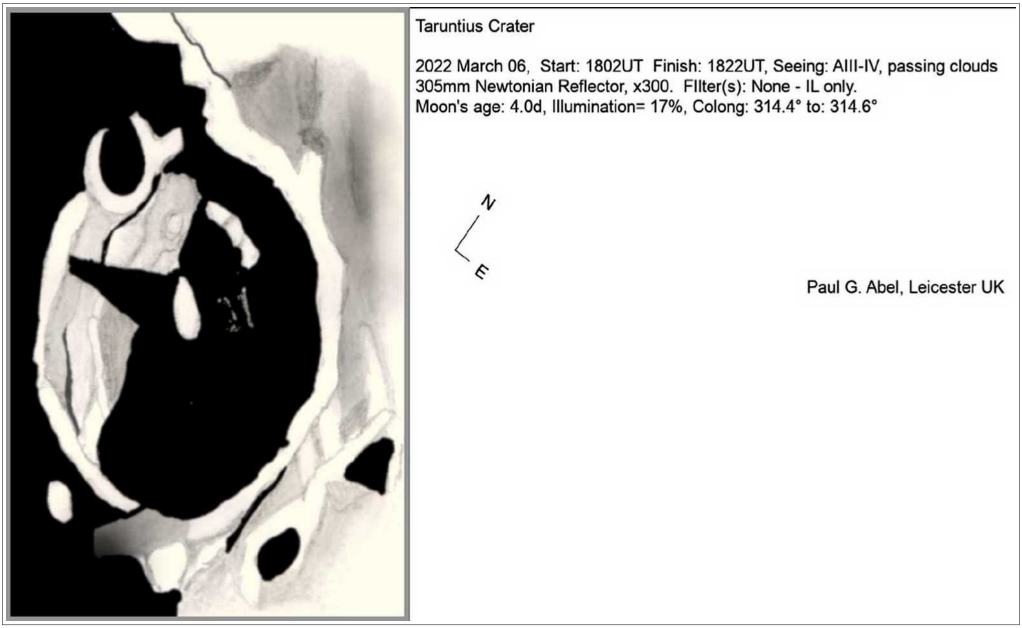

Figure 1. A sketch of Taruntius by Dr Paul Abel – see sketch for details on the date, UT etc.

COLOUR IMAGES OF THE LUNAR DISK.
By Peter Tickner.

Although the Moon is pretty much grey to most of us, hints of colour can sometimes be seen by the human eye, most notably blueness in the bright ray crater Aristarchus, but often very little else. British amateur astronomer, and prolific astronomy book writer, Peter Grego, once commented that colour becomes easier to see by visual observers at lower magnifications and he could just about detect colours in some of the lunar seas this way.

Modern colour webcams, and one-shot astronomical colour cameras, are much more sensitive than the human eye, and can really show up the subtle colours on the lunar surface that are due to minerals, especially if one uses 12 or 16 bit images. In Fig. 2 we see two colour images, taken with different equipment at different phase angles. The calibration of colour camera images is notoriously difficult. Two colour images, taken by different observers will often look different.

However, as a reader of this newsletter take some time to glance between the left and right images, looking for similarities. Most of the mare has a blue/purple cast, whereas the highlands have a more white/brown hue. The mare have some subtle colour variations so, for example Mare Serenitatis, Mare Frigoris and Mare Humorum are slightly redder than most other seas due compositional variations in Titanium and Iron in the basalts in these seas.

Figure 2. Both the following images were taken in colour and then had their colour saturation increased. (Left) Taken by Peter Tickner on 2022 Mar 14 UT 18:15 – original from: https://flic.kr/p/2n8VHcD . (Right) Taken by Mário Roi Abade during Full Moon in 2022 March.

SCHICKARD.
By Trevor Smith.

Trevor comments: *"On 17/03/22 the 100% full moon was riding high in the clear south eastern sky. On commencing observations, the large old impact crater of Schickard was immediately obvious near the south western limb. At some 212km in dia this giant walled plain which has a depth of around 1.5 km was a remarkable sight. The only drawback was the usual poor seeing here in Codnor at around ant lV. At first glance its ancient rims looked very linear due to foreshortening. They enclose a relatively flat floor dotted with small craters. The inner slopes are very complex and defied my attempts to* *draw them with any accuracy.*

The rims were noticeably broken in many places as they had been peppered with many small impact craters. Elger described Schickard as one of the grandest walled plains on the moon with a level floor abounding in fine detail. A young Patrick Moore observed Schickard on 2nd of April 1939 and found the floor covered in an extensive mist which obliterated all visible details On, 31st of August 1944 H P Wilkins saw very much the same thing so it is as well to keep a check on the crater just in case.

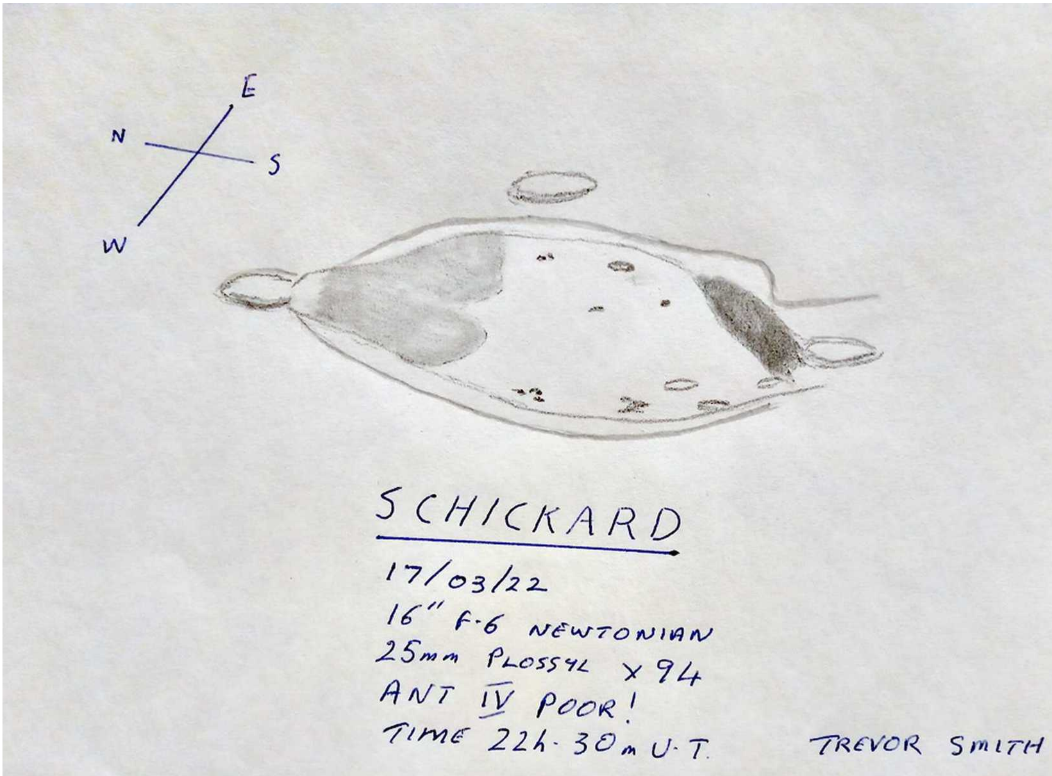

Figure 3. Schickard as sketched by Trevor Smith at the date and UT given in the sketch.

What caught my eye tonight was the two dark patches at either end of the crater. These are of course permanent features and are not in any way spurious. I have seen them many times before but tonight they looked to be especially pronounced and easy to see. The larger of the two is found occupying around one third of the northern floor and is noticeably the lighter in hue. The other is much smaller but makes up for this by being easily the darker. It lies on the extreme south /Eastern part of the floor and whereby the larger patch has a somewhat feathered edge the smaller one has a notably sharp linear edge. Both patches really stood out tonight. The centre portion of the crater was the *same colour as the background maria. The full moon is often cited as the worst time to explore the lunar surface but with a little patience it is surprising what can be seen. The judicious use of filters can also be a help in reducing glare."*

BULLIALDUS.

By Lars Lindhard.

As part of the lunar schedule programme, this is our first attempt to obtain new observations under similar illumination to L.F. Ball's sketch of this crater. Although Bullialdus in Lars's image was just 14 pixels across, it was possible to register and overlay it on Ball's 1949 sketch in order to add some topographic shading, albeit of low spatial resolution. One thing I note immediately was that L.F. Ball left out the crater Bullialdus A on the SE of the main crater. This is often a dilemma facing visual observers of what to include beyond the main feature being studied.

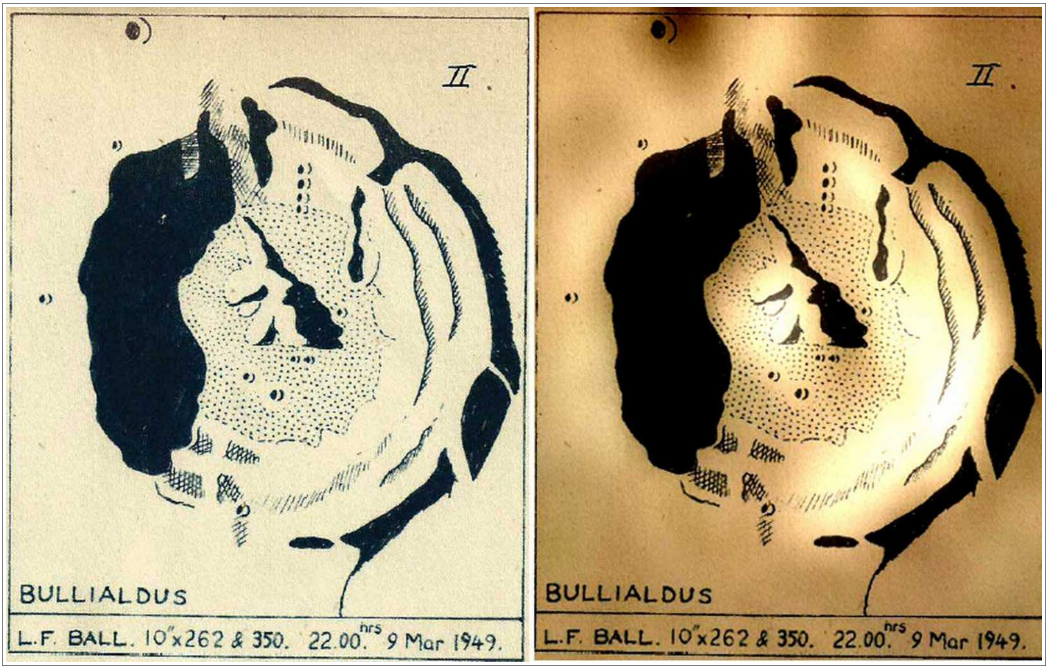

Figure 4. Bulliadus orientated with north towards the bottom. (Left) A sketch by L.F. Ball from Edition No. 1, Vol. No. 1 of The Moon. (Right) The same sketch but overlaid with a colour image by Lars Lindhard taken on 2022 Mar 13 at UT 19:45.

APOLLO 14 LANDING SITE.
By Valerio Fontani

Apollo 14, like the previous two successful landers, was targeted at a relatively flat area – in this case just north of the lava flooded 80 km diameter Fra Mauro crater. Fig 5 is the view that astronomers would have seen from Earth at the moment of landing on 9th Feb 1971 by the Antares Lunar Module lander i.e., the illumination would have been identical.

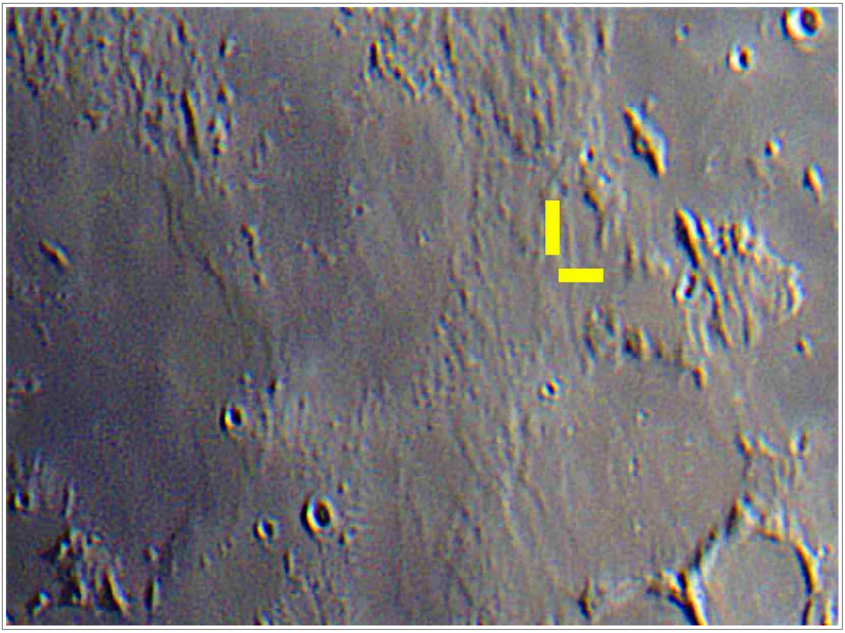

Figure 5. The Apollo 14 landing site as imaged by Valerio Fontani on 2022 Mar 12 UT 19:11 using a Meade LX 200 scope. The yellow bars indicate the approximate location of the Apollo 14 landing site.

ENDYMION.
By Rik Hill.

Rik comments: *"The center of this image is dominated by the large flat floored crater Endymion (129km dia.) one of the earlier features you can identify only 3 days after new moon. Its dark floor helps in the identification. Down below are two equally familiar craters, Atlas (90km) on the right and Hercules (71km) on the left with the nice secondary crater Hercules G (17km) on its floor. Just above these two craters are the easternmost shores of Mare Frigoris.*

Beyond Endymion near the limb is the large flat region that is Mare Humboldtianum but beyond the Mare is the limb of the moon and it's not a sharp curve. It's quite irregular and rough. Those are the huge peaks on the far side of the Mare, over the lunar horizon. As a kid in the early 1960s, armed with my 2.4" Tasco refractor, I used to love to look for these irregularities to the limb and when I saw ones of a shallow "W" shape I'd fancy that I was seeing the profile of some large crater. Maybe yes, likely no. Moving to the north end of the Mare we see more irregularities likely the high crater walls of Bel'kovich A and B on the farside of the Mare.

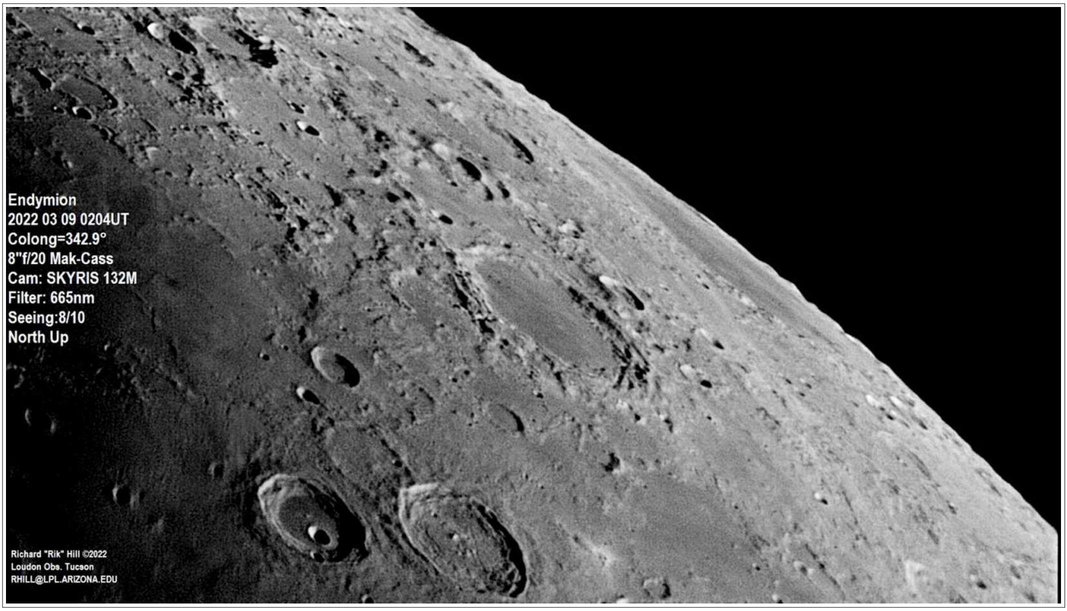

Figure 6. Endymion as imaged by Rik Hill with north towards the top. For dates and UT etc see the image. The image was made from two 1800 frame AVIs, stacked with AVIStack2*IDL) and knitted together with MicroSoft ICE and finally processed with GIMP and IrfanView.

You can explore features like these by using the Gazetteer of Planetary Nomenclature (planetarynames.wr.usgs.gov/Page/Moon1to1MAtlas) but you'll have to be patient because there's a lot of hunting around you need to do identifying known feature to find the unknown.”

STOFLER.
By Leo Aerts.

Stofler is a 126 km diameter crater in the southern lunar highlands. It has a relatively dark lava flooded floor, but despite this has been heavily eroded. Some light bands can be seen running across its floor and are ejecta rays from Tycho crater.

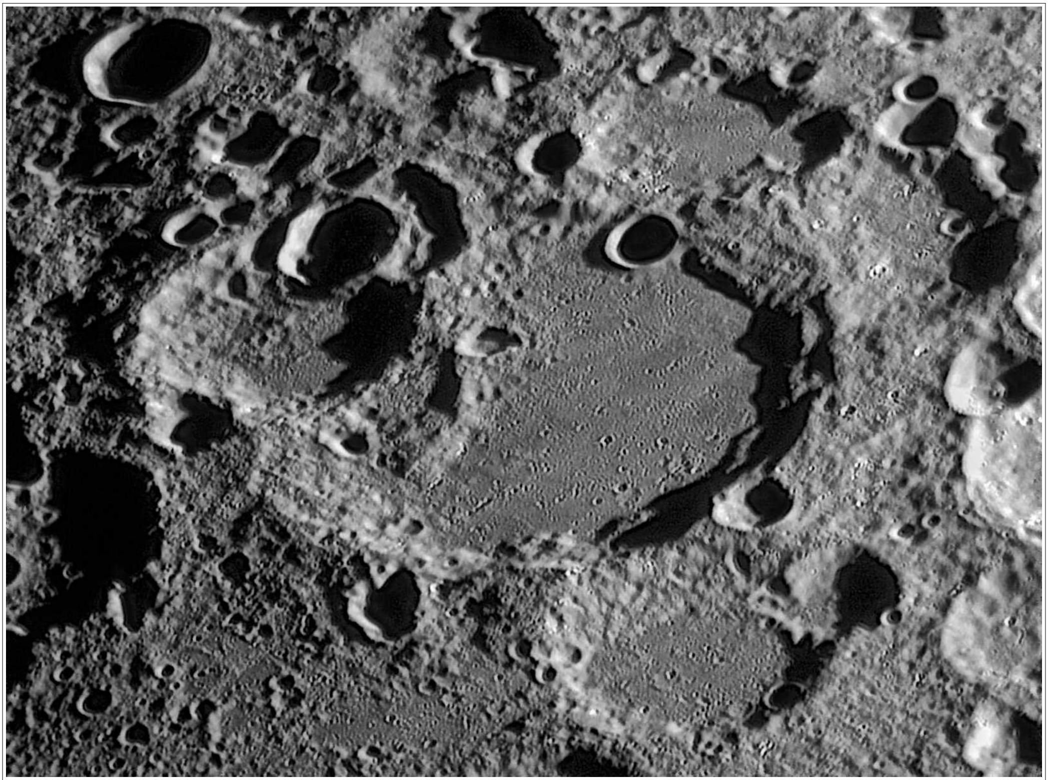

Figure 7. Stofler crater – a reworked image taken by Leo Aerts originally on 2016 Aug 24 with a Celestron 14" scope using an ASI 290MM camera with a red filter.

GASSENDI.
By Bill Leatherbarrow.

Gassendi is named after Pierre Gassendi (1592-1655) and is 110 km in diameter with the prominent crater Gassendi A on its northern rim and part of the Mare Humorum basin ring coming off the SW flank. The floor of the crater has a set of floor fractures and other rille like features can be seen in the highlands to the west of the crater and a rather spectacular one crosses the floor of Gassendi B.(N of Gassendi A) indeed the N rim of B looks like it has slid side ways, or at least perhaps has an incised valley?

Figure 8. Gassendi as imaged by Bill Leatherbarrow on 2022 Mar 14 UT 2128 (Col =53,4°) . North is towards the top left.

** For more on Gassendi B see LSC's Vol. 58 No. 5 May 2021 and Vol. 58 No. 6 June 2021. Ed.*

VITELLO & RAMSDEN.
By Bob Stuart.

Vitello is a 42 km diameter crater south of Mare Humorum and is unusual in that it has some zig-zag like concentric floor cracks and inside these a greater number of boulders than is present in most other craters. This could potentially infer geologically recent seismic activity, though there maybe other explanations. Ramsden by comparison is a flat floored 25 km crater that mostly over sits some linear graben.

Figure 9. Bob Stuart captured the above image of Vitello and Ramsden craters. Date, UT and other image details are contained in the image.

PETAVIUS.
By David Finnigan.

Petavius is a 177 km diameter crater near the SE limb of the Moon and as you can see has a characteristic radial rille on its SW floor, though there are some other less linear rilles elsewhere on the floor. The inner rim of Petavius is broader than most craters of this size. The crater dates from the lower Imbrium age.

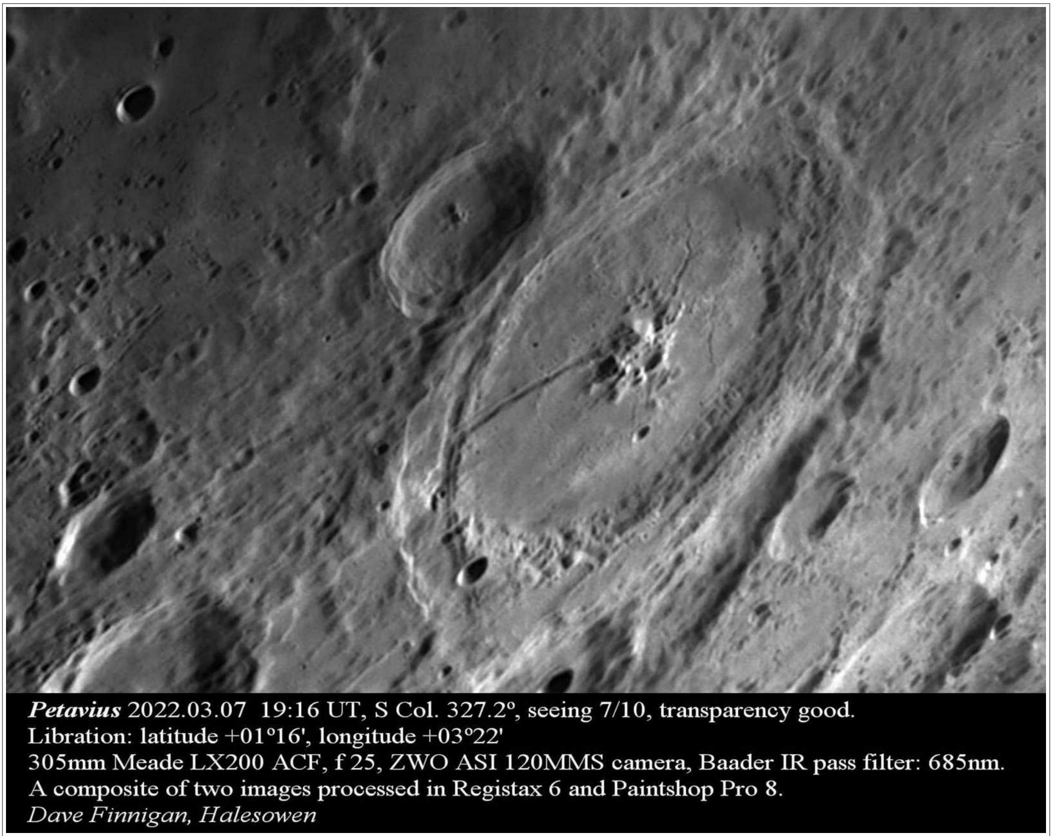

Figure 10. Petavius as imaged by David Finnigan with north towards the top. Image details etc are available at the bottom of the image.

POSIDONIUS.
By Rod Lyon.

Posidonius is a 95 km diameter crater, NW of Mare Crisium. If you are curious about this crater then you would do well to read Barry Fitz-Gerald's article in the 2021 Oct LSC.

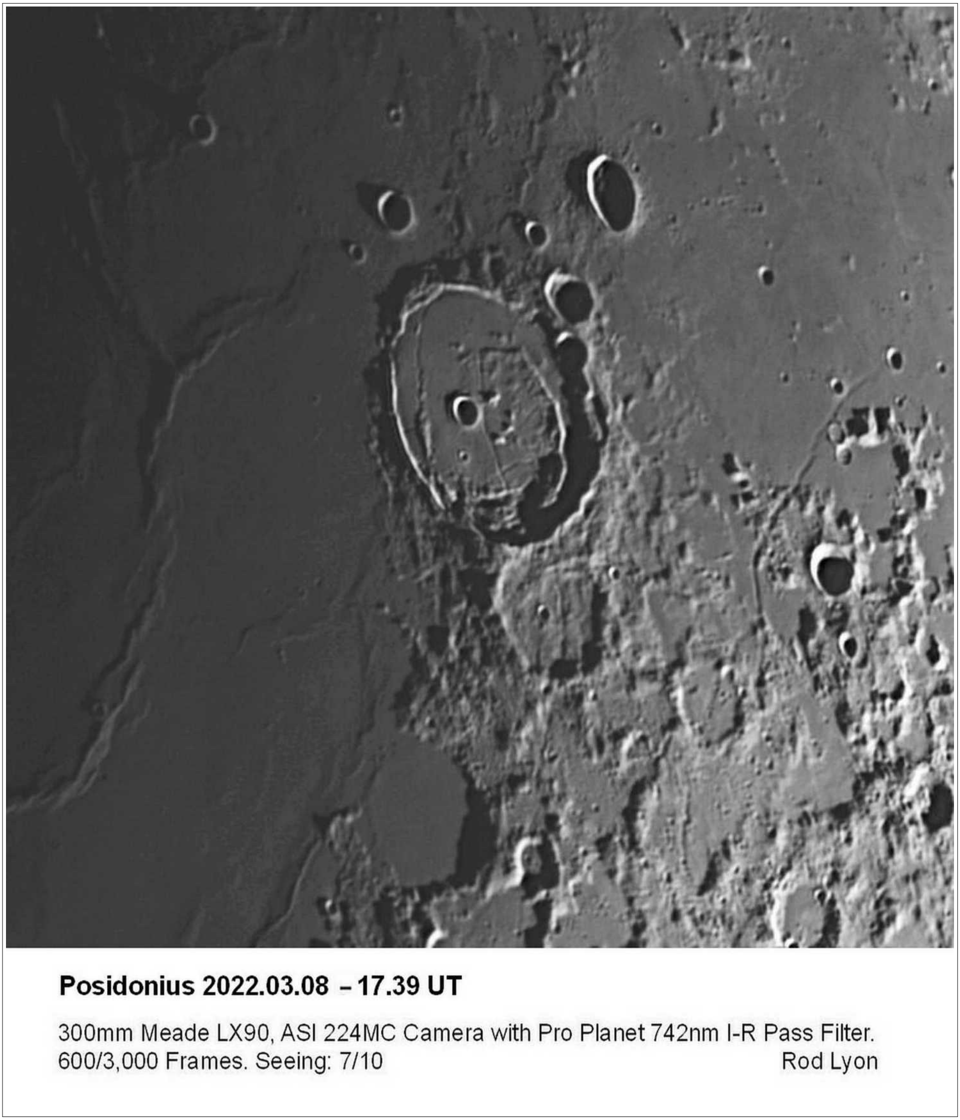

Figure 11. Posidonius as imaged by Rod Lyon. Date, UT and other details are given in the image.

LAMBERT & LAVA FLOWS.
by K.C. Paul.

K.C. says that Fig.12 is an image showing the youngest lava flows in Mare Imbrium. The flow front is quite close to the morning terminator and thus stands out more prominently. To its north-east, the other part of the flows are less obviously discerned. The southern portion of the lava flows seems to be blocked by Dorsum Zirkel.

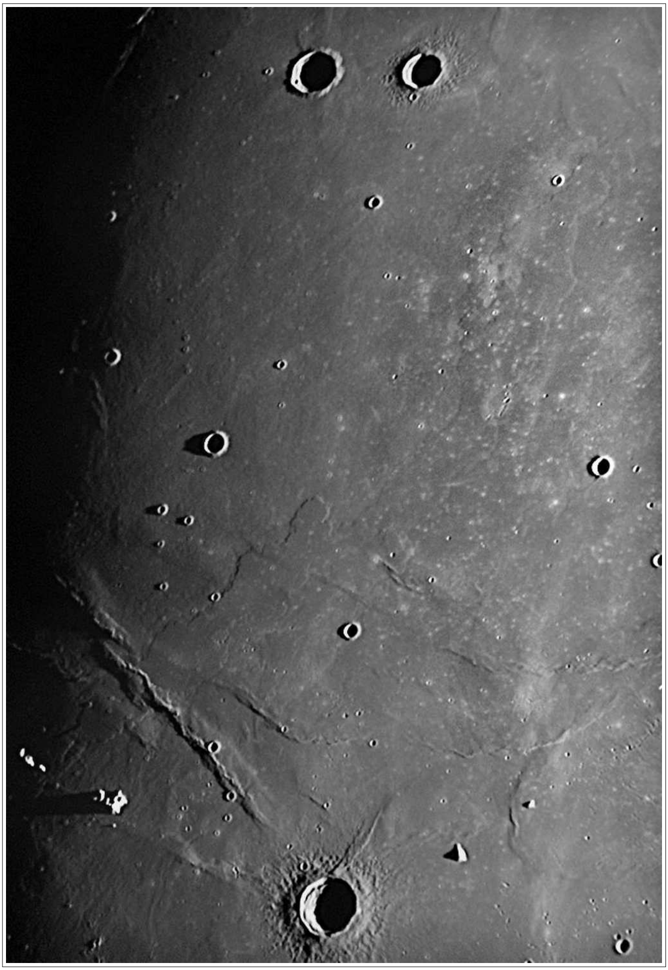

Figure 12. Lambert and the region to the north as imaged by K.C. Paul on 2017 Jan 7 UT 13:39. Taken with a 250mm f/6 Newtonian reflector + 12mm eyepiece projection + DMK 31AF03.AS camera.

ELGER'S HOOKED SHADOW IN COPERNICUS.
By Bill Leatherbarrow

The observational notebooks of Thomas Gwyn Elger, the first Director of the BAA Lunar Section are one of the great treasures of the BAA archive. Notebook number 5, covering the period 1888-1889, contains a fine drawing of Copernicus (Fig.1) made on 1889 March 11th between 19.50 and 20.45 UT. The instrument used was Elger's 8.5-inch reflector at a magnification of x340, under very good seeing conditions. South is up in Elger's drawing.

Fig.1 Copernicus drawn by Thomas Gwyn Elger on 11th March 1889.

The observation shows an unusual hooked shadow cast on to the crater floor from the eastern (IAU) rim. It is reminiscent of H.P. Wilkins' famous observation of 'Plato's hook', a similarly curved shadow that Wilkins observed on 1952 April 3rd, using the great 33-inch Meudon refractor in the company of Patrick Moore. Wilkins' sketch from that evening is reproduced on p. 234 of Wilkins & Moore, *The Moon.* There is not much by way of confirmation of Wilkins' observation, although our colleague Maurice Collins did image something approximating to Wilkins' sketch on 2009 May 3

I have seen nothing that might stand as unambiguous confirmation of Elger's observation of a 'Copernicus hook'. However, on the evening of 2022 March 12 at 20.23 UT I did observe a projection of the interior shadow cast by the east wall of Copernicus in approximately the same location as Elger's hook (Fig.2). It is clearly associated with the large scallop visible on the eastern rim in both my image and Elger's drawing.

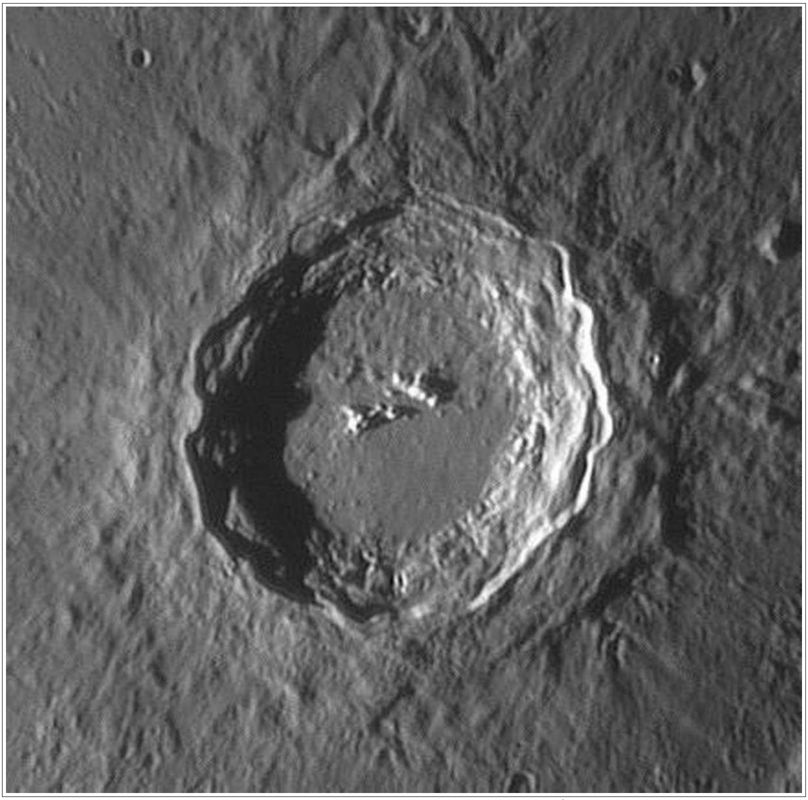

Fig.2 Copernicus imaged by Bill Leatherbarrow on 12th March 2022 at 20:23UT.

There are slight differences in the Sun's selenographic colongitude between my image and Elger's observation, the Sun being slightly higher over the area in my image. As a result it shows a shorter and less obviously hook-shaped shadow. I have a lot of faith in the accuracy of Elger's observation and it is likely that the hooked appearance of the shadow is the result of it curving around one of the many hummocky mounds that abound on that part of the floor of Copernicus. There is a hint of this in my image, which is inverted to coincide with the orientation of Elger's sketch. This is a minor issue, to be sure, but it would be good to keep an eye on this feature in the hope that we might obtain fuller confirmation of Elger's beautiful sketch.

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Lunar Occultations April 2022
By Tim Haymes

Time capsule: 50 year ago in the 1972 issue:
[With thanks to *Stuart Morris* for the LSC archives]

- Mr G. Amery (Reading) reports three timings (Pleiades) on 1971 Dec 29th

- He also reports three unidentified 8/9 magnitude stars on 1972 Jan 24th [All with 25cm, stopwatch and telephone time signal].

[Sub-editor: These observations are not in the Occult4 data base. It might be possible to get them added. I owe much of my early observational interest to Mr Amery's enthusiasm so its good to see his reports in the circular.]

Winchester Weekend 2022.
I look forward to meeting LS observers on the Saturday afternoon – it has been a long time, too long.

Observations reported.
T. Haymes: DD events were timed on March 13th and 14th from Steeple Aston, OXON

SAO80105	Mag7.9	DD 2331 : 17.93	CA 86N
SAO80693	Mag8.1	DD 2348 : 08.02	CA 76S

Instrument was a C11 with F6.3 focal reducer, QHY174mGPS camera in SER format at 25 fps and recorded with SharpCap pro. Time extraction was with TANGRA.
No time-corrections are needed when using a QHYGPS camera and TANGRA software. The time stamp is the start of the exposed frame and Tangra provides the mid frame time on the light curve. If the star is faint, then its possible to re-play the SER by frame advance (no light curve). In this case the time should be corrected manually by adding half the frame duration. (e.g. 0.02 sec). The timings were entered on the Occult4 report form.

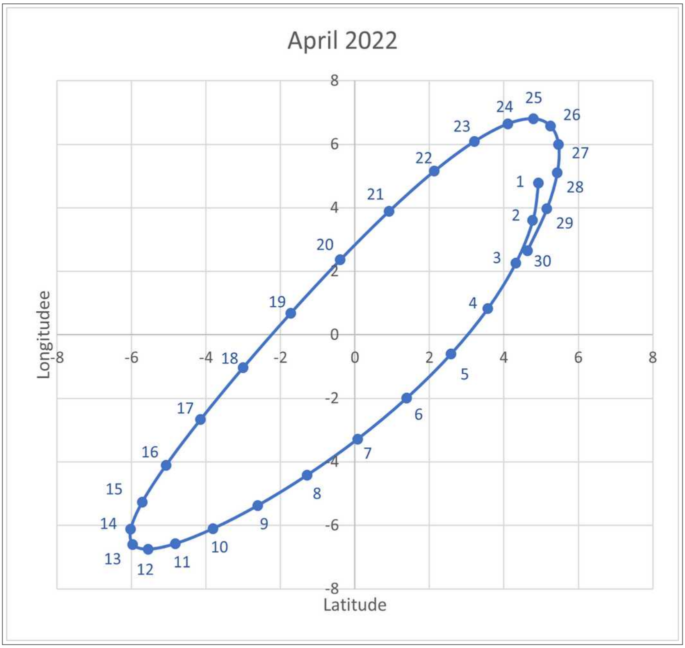
Occultation predictions for 2022 April (Times as other locations will +/- a few minutes)

E. Longitude - 1 18 47.1, Latitude 51 55 40.3. To magnitude 8.5

yy	mmm	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
22	Apr	3	21	11	54.5	D	93111		8.5	7.8	7+	30		2	292	89N	
22	Apr	4	20	57	42.4	D	519	K5	7.6	6.7	12+	41		13	284	36S	
22	Apr	4	22	15	47.5	D	93526	A*	7.7	7.5	13+	42		3	298	68N	
22	Apr	5	20	45	26.0	D	76595	F2	8.0		19+	52		25	275	41N	Dbl*
22	Apr	5	21	41	5.0	D	660	A8	4.3	4.1	20+	53		17	285	36N	u Tau
22	Apr	5	21	52	1	Gr	660	A8	4.3	4.1	20+	53		16	**	GRAZE	nearby
22	Apr	6	22	43	53.4	D	795	A2	8.4	8.2	28+	64		17	289	52N	
22	Apr	7	0	13	0.5	D X	74164		8.6	8.4	29+	65		5	305	71S	
22	Apr	7	0	13	0.5	D	77144	A2	7.7		29+	65		5	305	71S	
22	Apr	7	19	43	19	m	77960	G8	7.7	7.2	36+	74	-9	52	244	2N	
22	Apr	7	19	43	37	Gr	77960	G8	7.7	7.2	36+	74	-9	51	**	GRAZE:	nearby
22	Apr	7	20	5	49.7	D	77999	A0	8.1	8.0	36+	74	-12	48	250	58N	
22	Apr	7	21	50	40.9	D	932	*6	7.3*	5.6	37+	75		33	272	34S	TU Gem
22	Apr	8	20	2	54.2	D	78979	G5	8.1	7.6	46+	85	-11	55	234	71S	
22	Apr	8	21	42	6.8	D	79032	G5	8.4	7.9	46+	85		42	260	54N	
22	Apr	9	0	34	29.8	D	1085	G8	7.1	6.7	47+	87		16	291	26S	
22	Apr	9	0	35	47.9	D	79124	F0	7.8	7.6	47+	87		16	292	31S	
22	Apr	9	1	40	39.8	D	1094	A0	7.1	7.1	48+	87		7	303	71S	49 Gem
22	Apr	10	1	4	48.6	D	79910	M0	8.0	7.2	57+	98		18	287	76N	
22	Apr	10	1	24	3.4	D	79916	G5	8.4	8.1	57+	98		15	290	72S	
22	Apr	10	1	51	14.1	D	79926	G5	8.7	8.2	57+	98		11	295	49S	
22	Apr	10	2	54	50.6	D	1225	K0	8.1	7.5	58+	99		3	306	40S	
22	Apr	11	0	25	49.3	D	1330	G5	7.8	7.5	66+	109		29	269	25N	Dbl*
22	Apr	11	0	32	5.7	D	80499	K0	8.2	7.6	66+	109		28	270	61S	
22	Apr	11	1	14	55.4	D	80514	A*	8.5	8.4	66+	109		21	278	63S	
22	Apr	11	1	38	45.5	D	1334	G5	7.0	6.6	67+	109		18	282	57N	
22	Apr	12	1	11	41.1	D	98761	G0	8.6	8.2	75+	121		26	266	83N	
22	Apr	12	1	21	49.7	D	98751	G5	8.3	7.7	76+	121		25	268	20S	
22	Apr	12	2	28	38.1	D	1444	K0	7.8	7.1	76+	121		15	280	28N	
22	Apr	12	3	7	40.2	D	98802	F6	8.8	8.6	76+	122		9	287	72N	
22	Apr	12	19	56	25.8	D	1532	K0	7.6	7.0	82+	130	-9	50	151	49N	
22	Apr	12	20	32	20.3	D	1535	K0	6.9*	6.3	83+	131		52	165	56S	
22	Apr	12	21	10	50	m	99159	K0	8.9	8.3	83+	131		53	180	6N	
22	Apr	12	21	23	23.9	D	99160	G0	8.9	8.5	83+	131		52	185	43S	
22	Apr	12	22	32	24.5	D	1544	M2	5.4*	4.5	83+	131		49	210	65N	46 Leo
22	Apr	12	23	20	25.2	D	99179	K5	8.6	7.8	83+	132		44	225	89N	
22	Apr	14	1	21	1.9	D	118841	F5	7.6	7.3	91+	145		30	241	81N	
22	Apr	14	21	28	47.7	D	119239	K2	8.1	7.5	96+	156		39	156	41N	
22	Apr	14	22	44	45.5	D	119243	K	8.8*	8.2	96+	156		41	180	28S	
22	Apr	14	23	29	52.4	D	119261	K	8.9*	8.1	96+	157		40	195	37N	
22	Apr	15	3	8	40.2	D	119305	A2	8.9		96+	158		17	251	22N	
22	Apr	15	3	33	59.0	D	1767	A2	7.6	7.5	96+	158		13	256	29N	
22	Apr	15	4	7	39.4	D	119325	K0	7.6	7.1	97+	159	-10	8	262	88N	
22	Apr	18	2	5	49.1	R	158829	F0	8.7	8.4	98-	163		21	194	46N	
22	Apr	19	1	14	46.0	R	183793	K0	8.0	7.4	93-	149		16	168	8N	
22	Apr	19	2	37	19.3	R	2260	K0	7.6	7.0	93-	149		16	187	12N	
22	Apr	20	1	38	34.5	R	184678	K0	7.6	7.0	86-	135		11	160	24N	
22	Apr	20	2	40	53.5	R	184700	K5	8.3	7.4	85-	135		13	175	88N	
22	Apr	20	3	16	28.2	R	184725	F2	8.5	8.2	85-	135		13	183	85S	
22	Apr	20	3	29	42.2	R	2424	A0	6.9	6.9	85-	135		12	185	76S	

22 Apr 21	1 45 31.7	R	2575	A3	6.9	6.8	76-	122		5	150	53N	
22 Apr 22	4 47 17.3	DB	2784	K1	3.3	2.7	65-	107	-2	10	174	-79N	Tau Sag
22 Apr 22	6 0 28.6	RD	2784	K1	3.3	2.7	64-	107	9	10	191	80N	Tau Sag
22 Apr 24	3 47 5.6	R	190018	G8	7.5	7.0	42-	81	-9	4	136	25S	
22 Apr 24	4 6 10.6	R	3082	F3	7.1	6.9	42-	81	-7	6	139	46S	

Key:
P = Phase (R or D), **R** = reappearance **D** = disappearance
M = Miss at this station, Gr = graze near this station (possible miss)
CA = Cusp angle measured from the North or South Cusp.
Mag(v)* = asterisk indicates a light curve is available in Occult-4
Star No:
1/2/3/4 digits = Robertson Zodiacal catalogue (ZC)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue.
The ZC/XC/SAO nomenclature is used for Lunar work. The positions and proper motions of the stars in these catalogues are updated by Gaia. Please report timings to Tim Haymes in the Occult4 data format.



Lunar Libration Diagram April 2022

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Lunar Domes (part LVII): Fracastorius dome
By Raffaello Lena

In this fifty-seventh note I will describe a large lunar dome in Fracastorius, one of the features most photographed by astroimagers.

Figure 1: Image taken by Paolo Lazzarotti including the dome Fracastorius 1(Gladius XLI Cassegrain with aperture of 400 mm f/16).

Immediately to the north of the remnants of the northern crater wall lies a large and elongated lunar dome termed Fracastorius 1 (Fr1), with an evident vent on its surface.

The height of the large dome amounts to 340m ±50m near the vent and 440m ±50m at the highest point south of the vent. The average flank slope amounts to 1° near the vent but part of the eastern flanks are steepest than 2.7°. Its diameter corresponds to 37x27km. The image shown in Fig. 1, taken under strongly oblique solar illumination angle, displays the domical shape and its elevation. Another image of the examined dome (Fig.2) was taken by Viladrich using a 500 mm Ritchey-Chrétien telescope.

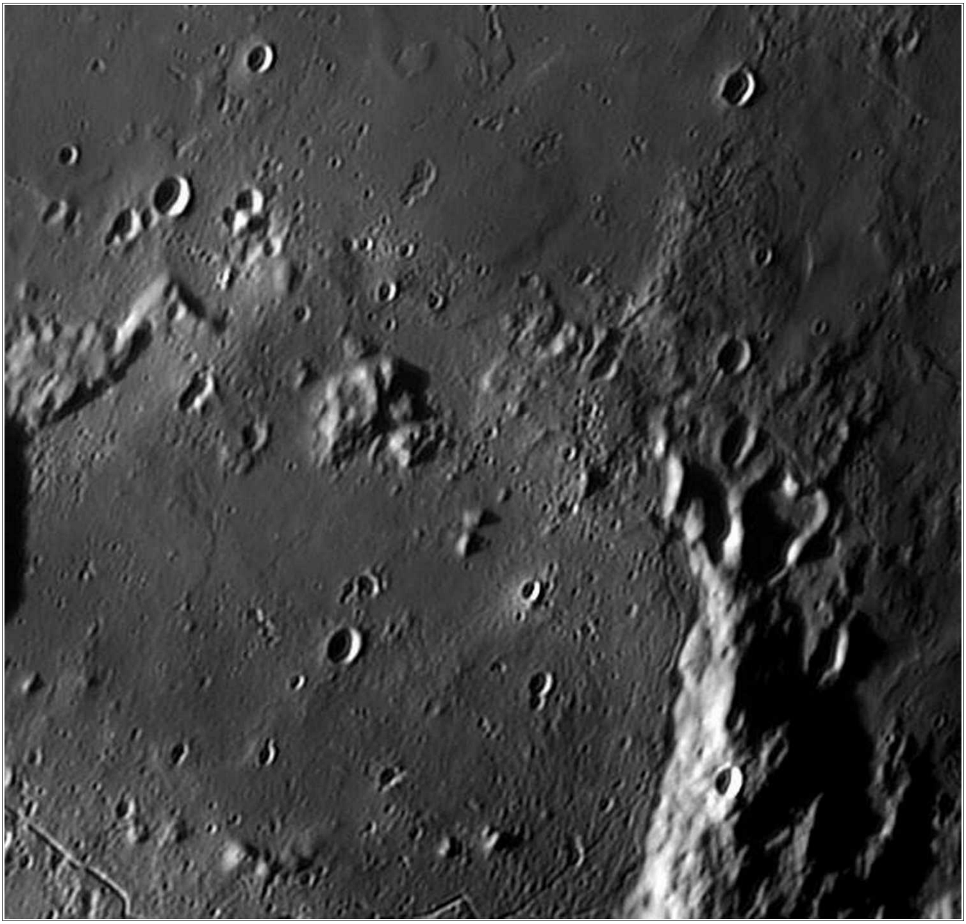

Figure 2: Image taken by Viladrich including the dome Fracastorius 1 using a 500 mm Ritchey-Chrétien telescope.

In figs. 3 and 4 are reported the global digital terrain model (DTM), used to analyze the topography of the examined region (Fig. 3) and the N-S profile of the dome based on LOLA DEM (Fig. 4).

The Clementine UVVIS spectral data of the dome Fracastorius 1 reveal a 750nm reflectance of $R_{750} = 0.1273$, a low value for the UV/VIS colour ratio of $R_{415}/R_{750} = 0.6010$, and a $R_{950}/R_{750} = 1.0647$.

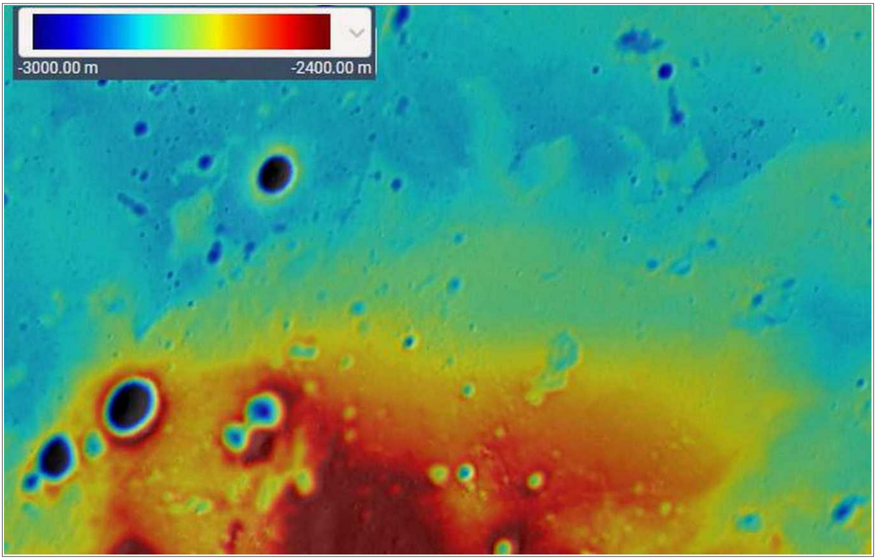

Figure 3: Elevation on digital terrain model.

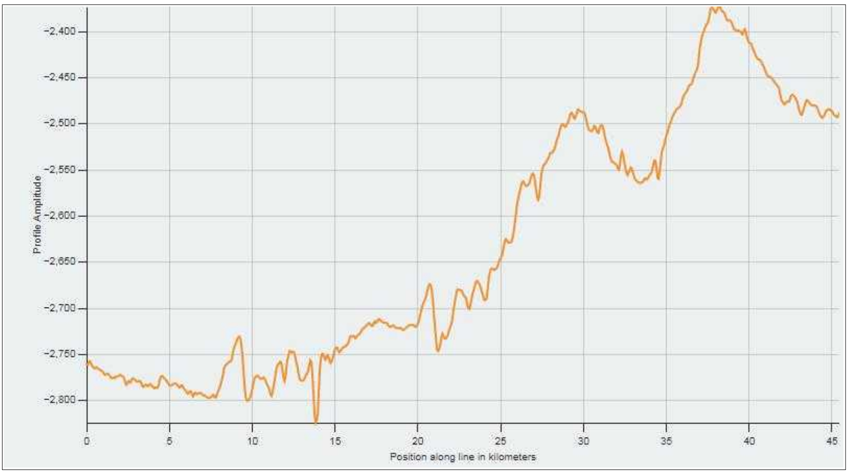

Figure 4: Fracastorius 1, profile in North-South direction.

The TiO_2 content-derived by the abundance maps created from topographically-corrected Mineral Mapper reflectance data acquired by the JAXA Selene/Kaguya amounts to ~2.0 wt %, while the FeO content varies from 12 wt % to 14 wt %.

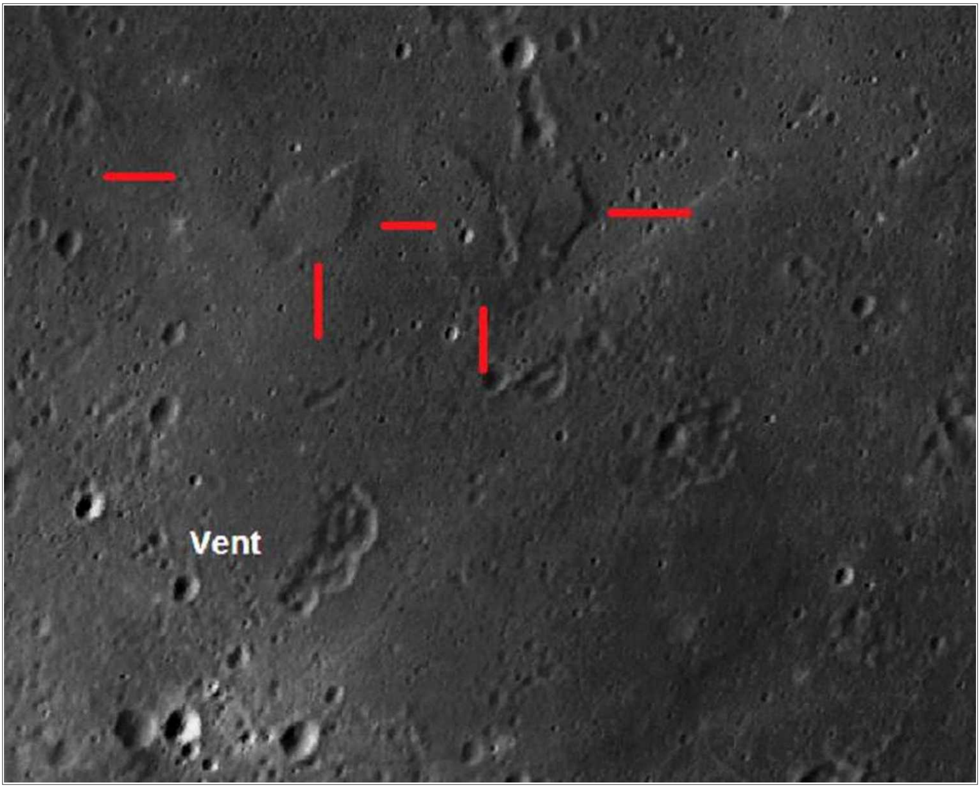

Figure 5: WAC imagery. The dome Fracastorius 1.

Moreover it displays further possible vents and complex texture with irregular small elevations in the northern part of the volcanic construct, likely due to several effusive activities occurred (Fig. 5).

The dome belongs to class D and probably represents a non-monogetic dome likely formed during several stages of effusion, similar to the domes A2 and A3 near Arago (known domes termed Arago α and β). The classification scheme, based on a quantitative analysis according to their spectral and morphometric properties, yields seven different classes. The lunar cones, originated by explosive activity, belong to a different cluster. A grouping of the domes based on a principal component analysis (PCA) in the space made up by eight spectral and morphometric features yields several clusters (cf. Fig. 6). Domes belonging to the same cluster share certain characteristic spectral and morphometric properties [1]: a similar scheme is used by Pike [2] for grouping terrestrial volcanoes. Specifically, these features are the reflectance at 750nm wavelength, the reflectance ratios R_{415}/R_{750} and R_{950}/R_{750}, the flank slope, diameter, height, edifice volume, and form factor.

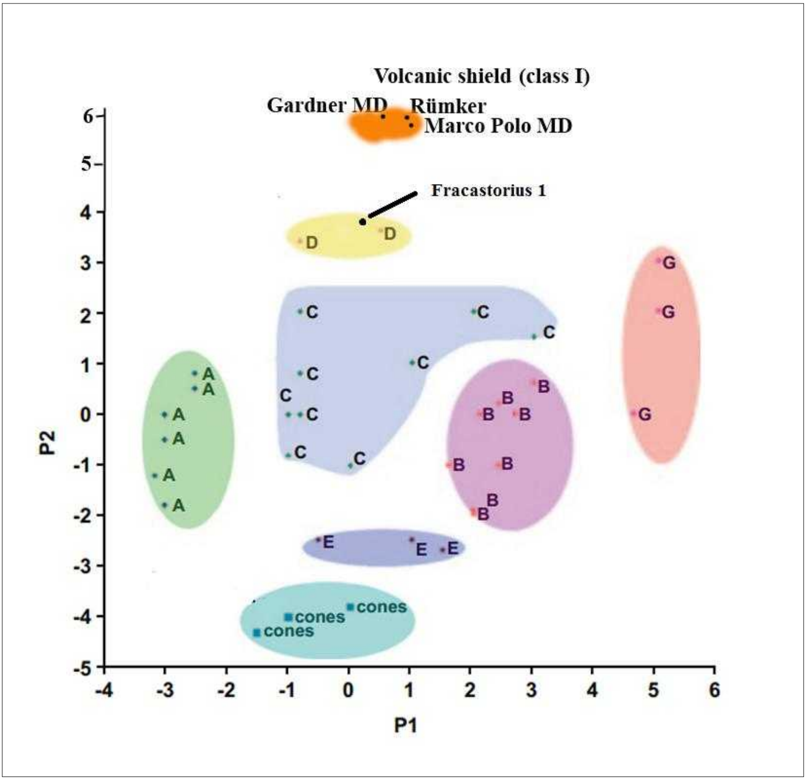

Figure 6: Classification scheme of effusive lunar mare domes introduced in reference [1, 3-4]. Scores P1 and P2 of the features vectors describing the domes on the first two principal components of the data distributions. In this subspace lunar domes form several clusters, which can be identified based on the correspondingly transformed dome coordinates (P1, P2 and P3), where the main groups appear in the coordinate system spanned by the first two principal components P1 and P2. The examined dome belonging to class D is marked.

Chandrayann-1's Moon Mineralogy Mapper (M^3) is an imaging reflectance spectrometer that can detect 85 channels between 460 nm and 3000 nm, and has a spatial resolution of 140 m and 280 m per pixel. For this work M^3 data- from orbital period OP1B- were calibrated and photometrically corrected and converted to apparent reflectance.

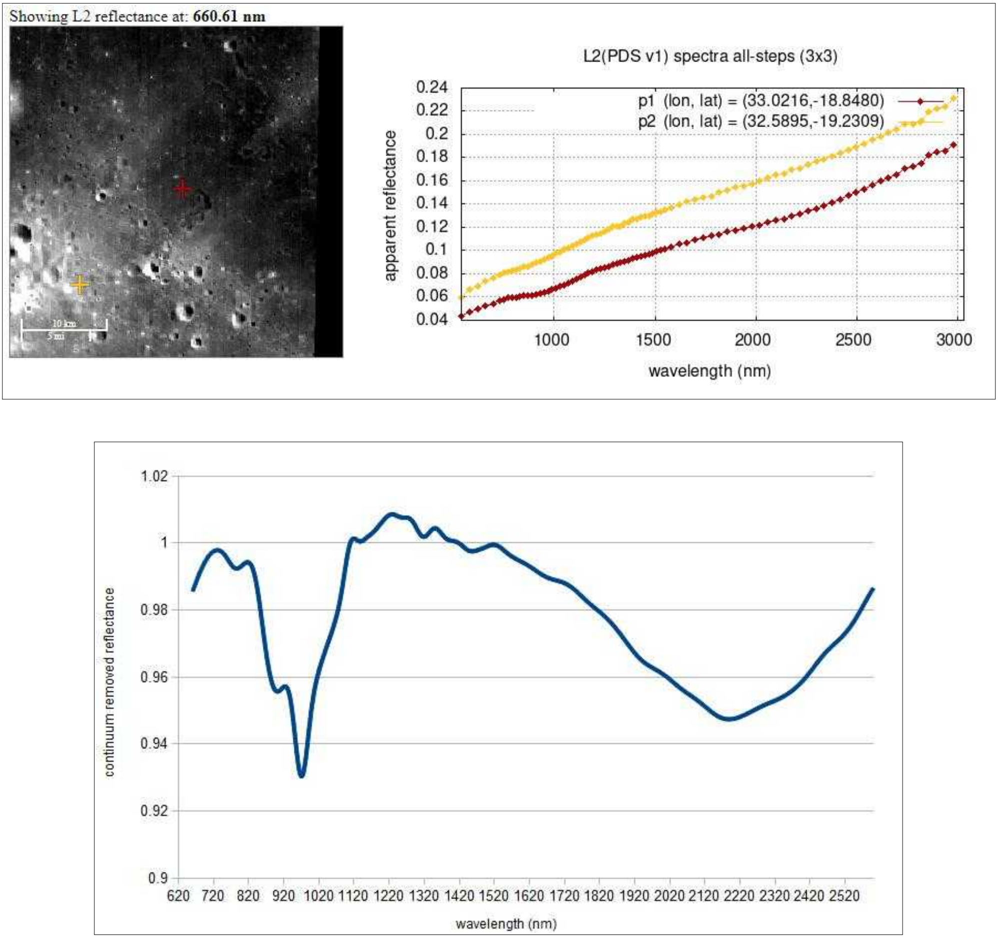

Figure 7: Chandrayann-1's Moon Mineralogy Mapper (M^3). Top spectra of the dome and nearby highlands. Bottom spectrum of the dome Fracastorius 1 after continuum removed.

The spectrum of the dome (Fig. 7) displays a trough around 1,000 nm with a minimum wavelength at 980 nm and an absorption band at around 2,200 nm, corresponding to a typical high-Ca pyroxene signature [3], indicating a basaltic composition. The highland to the north of the dome displays a spectrum of more feldspar composition which clearly lacks any observable mafic absorption feature in the range between 1,000 and 2,400nm. Thus the dome consists of basaltic material. Fracastorius crater has been severely modified. It tilted into the subsiding Nectaris basin, with lava rushing in to inundate. Fracastorius has fractures running in E-W direction on its floor, and likely formed as the weight of Mare Nectaris lavas caused the center of the Nectaris basin to subside. Hence, Fracastorius 1 dome represent clear evidence of volcanic activity occurred in this lunar region.

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[1] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. Lunar domes: Properties and Formation Processes, Springer Praxis Books.
[2] Pike, R. J., 1978. Volcanoes on the inner planets: Some preliminary comparisons of gross topography. Proc. 9th Lunar Planet. Sci. Conf., pp. 3239-3273.
[3] 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.

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Mare Imbrium.
By Barry Fitz-Gerald.

The multi-ringed impact basin Mare Imbrium is probably the most familiar feature on the lunar surface, and as such is probably one of the most studied areas of the moon. Its formation is believed to have resulted from a low angle asteroid impact from the north-west, with the resulting ejecta scouring the surface downrange to the south-east, producing the crater chains and gouges that make up the so called 'Imbrium Sculpture'[1][2][3]. This interpretation formed the basis for many later studies with the most recent iteration suggesting that the asteroid responsible for the basin suffered 'decapitation' or shear failure of its upper parts at an early stage of the impact process[4] with the debris continuing downrange, with virtually undiminished velocity, to impact the surface and produce the groves and lineations of the sculpture.

The orientation of various elements within the sculpture compares favourably with experiments involving hypervelocity low angle impacts, and provides additional support for the prevailing view of the basin origin. The bulk of evidence for the low angle impact hypothesis outlined above is fairly compelling and supported by a substantial amount of evidence from a variety of sources. There are however some factors which leave me not wholly convinced of this version of events, and at the risk of sticking my neck out far to far in the face of the prevailing view, I think it might be worth floating one or two ideas that have been bothering me. To begin with though, it is worth having a quick look at the Imbrium Basin to re-acquaint ourselves with the topography before moving on to Mare Crisium, which is believed to be another basin formed during a low angle impact event[5][6].

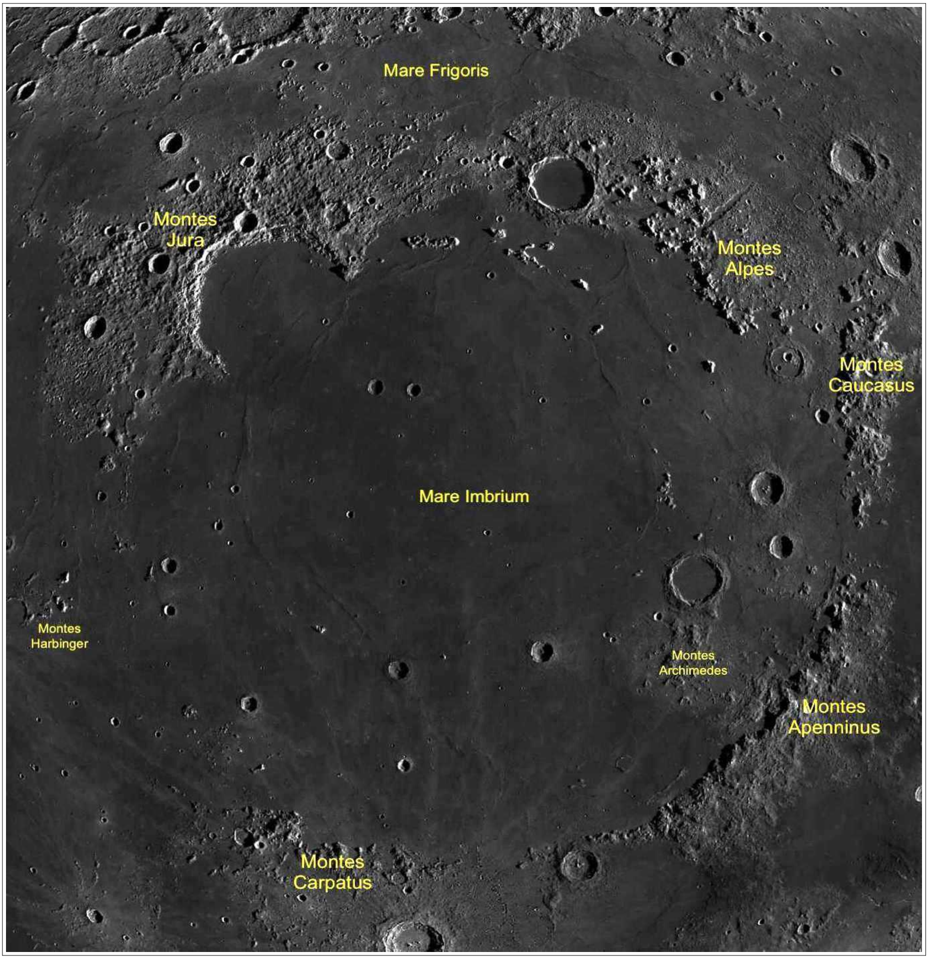

Fig.1 The Imbrium Basin with major topographic components labeled.

As can be seen in Fig.1, the outline of the basin is well defined to the south-east by the arc of Montes Apenninus, which would be the down-range rim of the basin in the prevailing view where the impactor arrived from the north-west. Montes Caucasus to the north-east and Motes Carpatus to the south both continue along the same arc suggesting they are separate but continuations sections of the basin rim. Montes Alpes, location of the famous Alpine Valley, looks by contrast a little out of place, as if part of the north-eastern rim has slid towards the basin centre along a slip-strike or transverse fault. These types faults, where one block slides horizontally relative to its neighbour, are common on the Earth with its mobile crustal plates, but such faults do not appear as geological features on the Moons rigid carapace. There is an absence of any conspicuous rim type structures to the north which is dominated by the eyebrow like Mare Frigoris. This is explained as being the result of the the collapse of this section of rim due to the low angle impact dynamics. To the west, the only hints of a rim may be the isolated peaks of Montes Harbinger and the Aristarchus Plateu, but this direction is dominated by the vast gulf where Mare Imbrium opens up into the larger Oceanus Procellarum. Fitting any hypothetical rings to the basin is therefore something of an uncertain process bearing in mind the absence of much in the way of rim like structures to the north and west. An apparent uplifted inner ring is defined by various massifs which poke up from the basalt plains within the basin such as Montes Teneriffe, Recti and Spitzbergen as well as Mons Pico and a number of other isolated peaks, and within which a circular(ish) arrangement or mare ridges can be seen.

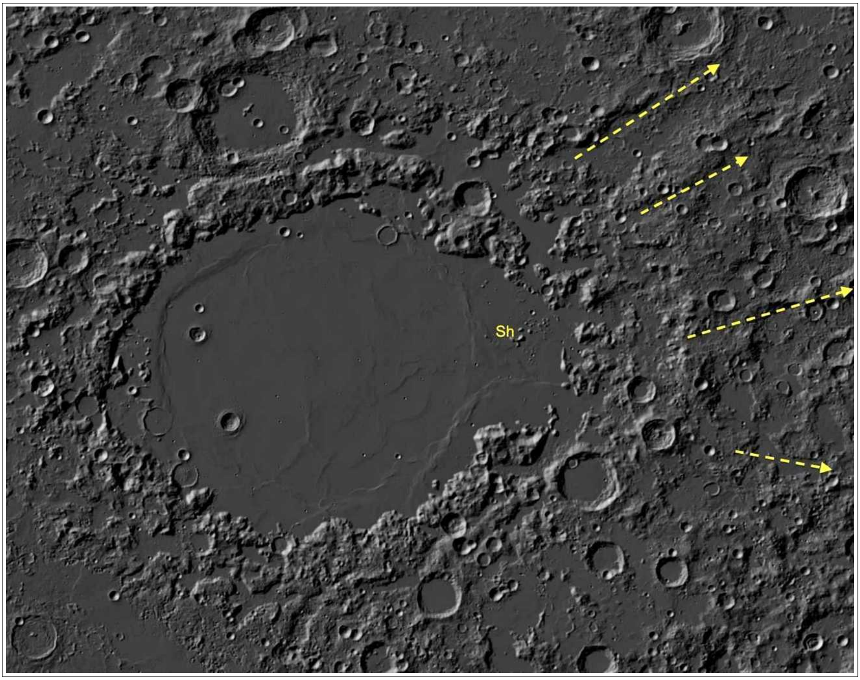

Fig.2 An LRO Quickmap rendition of the Crisium Basin with the 'Terrain Hillshade' layer enabled. Yellow arrows indicate linear gouges possibly the result of scouring by impactor debris. The eastern 'shelf' (Sh) indicates reduced depth of excavation in this direction as a result of the oblique impact from the west.

Moving on to Mare Crisium, Fig.2 shows this basin with its rather elongate outline, which is believed to be the result of the low angle impact from the west. Its rim exhibits the 'saddle' shape characteristic of smaller low angle impacts, with the western rim lower than the eastern, and the northern and southern rims of comparable height. Of note is an apparent breach to the rim in the east, and the presence of a shallow shelf like extension of the mare in that direction. This is hypothesised to be the result of "*downrange scouring by decapitated fragments*" of the disrupted impactor[6] with the shelf the result of shallower excavation in this direction. In addition to this shelf, linear valleys extend away towards the east, representing further scouring downrange. The deepest part of the basin lies within a ring of mare ridges to the west of the shelf, and presumably formed by crustal sagging as the basin filled with mare lavas.

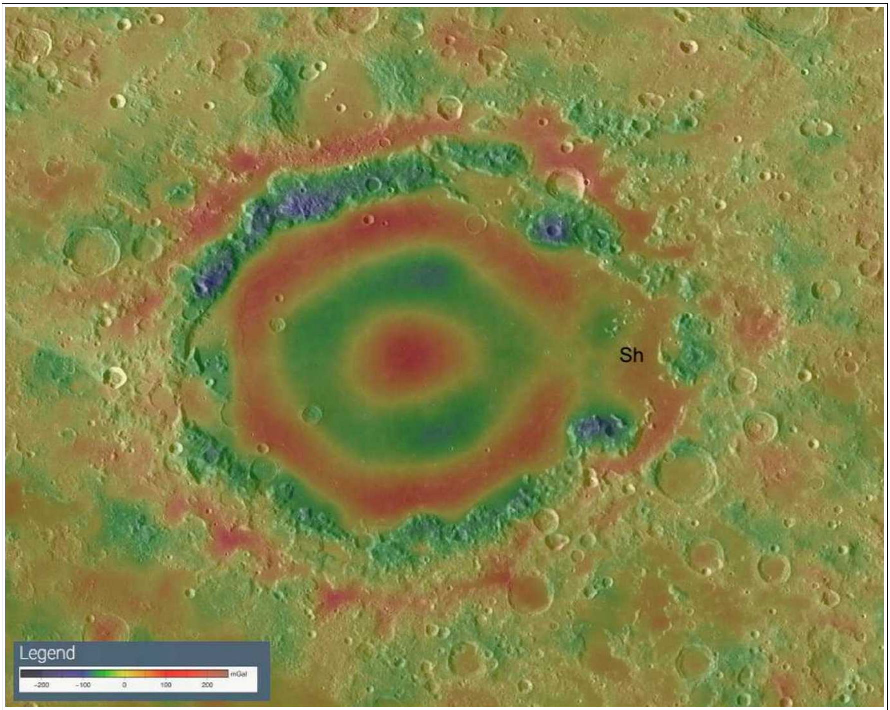

Fig.3 An LRO Quickmap rendition of the Crisium Basin with the GRAIL 'Bouguer gravity filtered from degree 60 to 660' layer enabled. Dense rock is shown in red less dense in greens and blue. Concentric rings represent the rim of crustal material (blue and green) and uplifted dense mantle material beneath the basin (red). Note the gap in the rings to the east.

Fig.3 is a LRO Quickmap image with a Bouguer gravity overlay enabled, which shows residual gravity which is derived from density variations within the lunar crust. The breached rim is visible as the horseshoe shaped green and blue structure, open to the east with the colour coding indicating uplifted crustal materiel. Within this is an elongate red ring – also open to the east- which probably represents dense mantle material which rose towards the surface during the formation of the basin. This shows that the 'breached ring' configuration is reflected in both the surface topography and the deep subsurface geology.

The Bouguer gravity gradient image of this basin shown in Fig.4, shows dense rock, probably in the form of basalt dykes deep within the crust as blue streaks, whilst the uplifted basin rim shows up as red. The significant factor is the quasi-radial arrangement of these possible dykes to the east of the basin and apparently converging towards the breached rim and inner ring. These may represent magma filled fractures which were generated when the basin formed, and whilst they are not the only such features radial to the basin, the fan shaped concentration on the eastern side is noteworthy. Being of Nectarian age, the Crisium Basin does not host an extensive system of ejecta features comparable to the Imbrium Sculpture, though geological mapping of suspected basin related units suggest a 'butterfly pattern' distribution consistent with a low angle impact[7]. One final point that is illustrated in Fig's. 3 and 4 is the rather 'squared off' appearance of the ring of mare ridges to the west within the basin, where another conspicuous 'shelf' occupies the margin of the basin. This 'squaring off' is reflected in the shape of the positive gravity anomaly (red ring) shown in Fig.3, and must therefore reflect an unusual configuration in the mantle uplift beneath the basin.

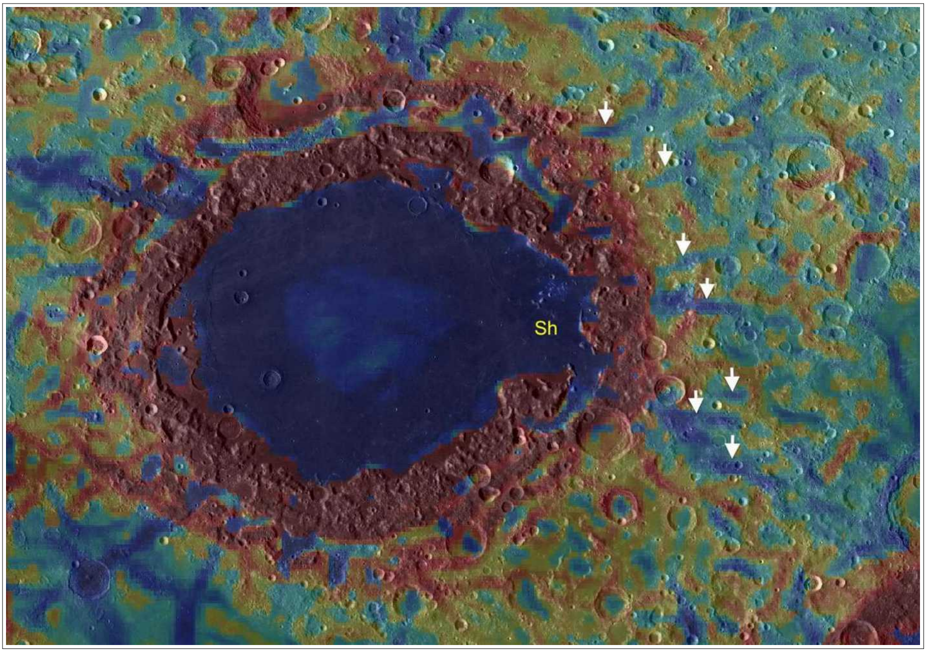

Fig.4 An LRO Quickmap rendition of the Crisium Basin with the GRAIL 'Bouguer gravity gradient layer enabled. Dense rock within the basin and sub surface dykes is shown in blue. Note the radiating fan of these features to the east (white arrows).

The eastern part of the Outer Rook mountains in Mare Orientale also shares this 'squared off' appearance, contrasting with the curved western part of the Outer Rook ring. This observation is interesting because it is proposed that the Orientale Basin also formed as the result of a low angle impact with a down-range azimuth of between 240°–265°, so essentially from the east[8], and which would place the straight section of the ring in the up-range direction as we see in Crisium.

Moving back to the Imbrium Basin we can see some features in the GRAIL image in Fig.5 that are somewhat reminiscent of those seen in Fig.3, including a breach in the uplift ring (represented by Montes Teneriffe, Recti,Spitzbergen and Mons Pico) and which in is line with the Montes Alpes front. The gravity signature on the opposite side of the basin also has a somewhat 'squared off' appearance, similar to that seen along the western edge of the Crisium Basin. In the case of Mare Crisium however the gap in the massif was in the down-range direction (east), whereas in the case of Imbrium this gap is towards the north-east and not the proposed down-range direction of south-east. Fig.6 shows a Quickmap image with a Crustal thickness map overlay enabled and what this additionally reveals is that towards the north-east there is an area of reduced crustal thickness where the basin centre is extended into a shelf like extension, similar to the shelf seen in the Crisium Basin.

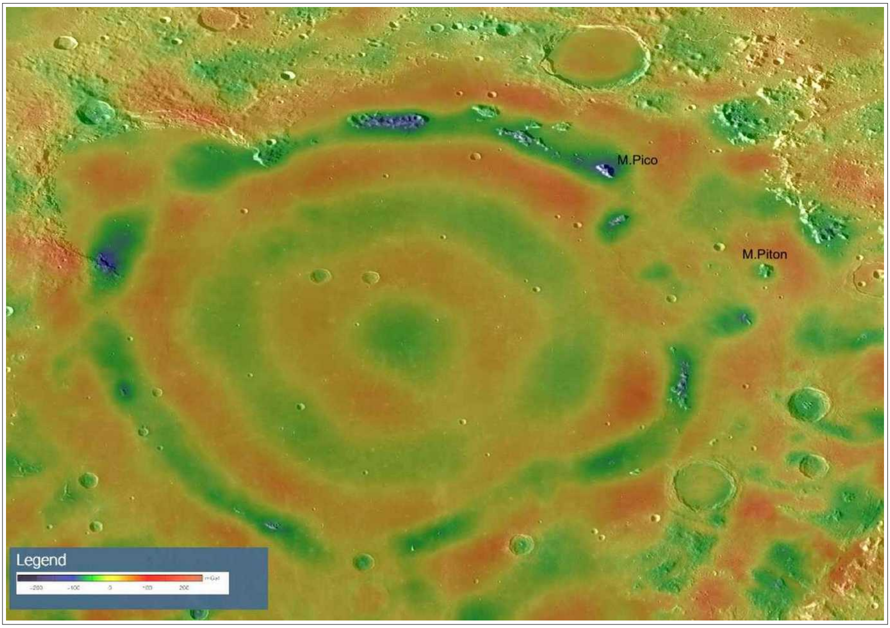

Fig.5 An LRO Quickmap rendition of the Imbrium Basin with the GRAIL 'Bouguer gravity filtered from degree 60 to 660' layer enabled. Note the gap in the inner ring (green circle) to the north-east which faces towards Montes Alpes.

Could this indicate that the Imbrium forming impact was therefore not as advertised, but the result of a low angle impact from the south-west instead? This would have potentially significant implications for our understanding of this basin, and so even suggesting it is somewhat fraught, but there are other lines of evidence that may support this conclusion.

Some evidence may be provided by the position and orientation of Montes Alpes which is offset from the northern terminus of the Montes Caucasus which itself lines up nicely with Montes Apenninus in what looks like a perfectly respectable basin rim. As already noted, this offset could be explicable in terms of movement of the Montes Alpes towards the centre of the basin along a transform fault, but these types of faults are unknown on the moon, and there is no obvious lunar geological process that could produce such a significant horizontal displacement. If however the Montes Alpes formed as a structure analogous to edge the 'shelf' seen in the Crisium Basin, this could account for the offset seen and the somewhat tangential line of the front of the massif when compared to the outline of the basin itself. The presence of a 'shelf' in the Imbrium Basin would also account for the rather peculiar location of Mons Piton, which is not actually a part of the uplifted ring represented by Montes Teneriffe, Recti and Spitzbergen and Pico. Thus Piton might represent an isolated massif on the 'shelf' and not part of an uplifted ring, and as such it is comparable to the small cluster of hills visible on the shelf of the Crisium Basin.

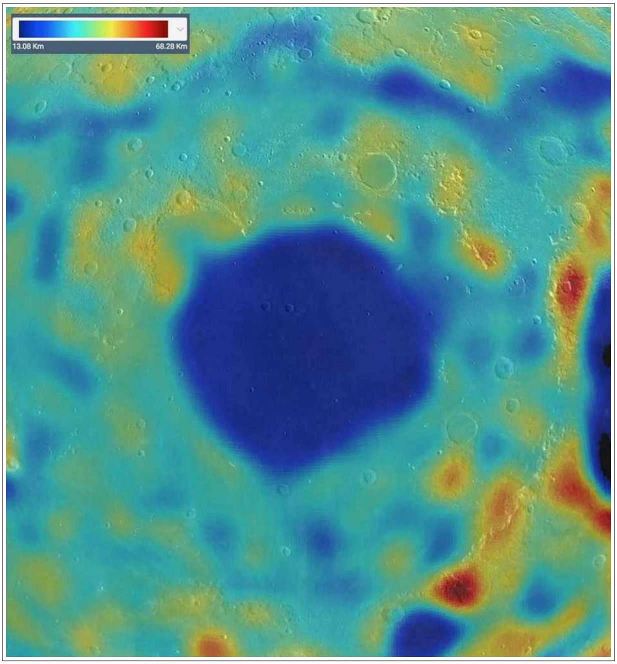

Fig.6 Quickmap image of Mare Imbrium with a Crustal thickness map overlay enabled. Note the shelf like extension of the area of reduced crustal thickness to the north-east which corresponds to the gap in the inner ring in Fig's 6 and 7.

Fig.7 (which uses the same colour coding as Fig.4) shows a fan of almost-radial linear features extending away to the north-east from the gap in the ring massif in a pattern very similar to that seen in the Crisium Basin. These may again represent fractures produced in the crust during the impact event and subsequently infilled with dense magma to produce dykes, one of which is located beneath the Alpine Valley. Clearly if the impact was from the south-west *this* would be the down-range direction and one might expect to find secondary impact structure here, similar to those seen around the Crisium Basin.

There are indeed many crater chains and lineations orientated radially away in this proposed down-range direction (such as to the east of W.Bond) but possibly the most significant feature may be the northwards bulge of Mare Frigoris between Aristoteles and Gartner where it forms a tongue of low terrain, orientated radial to the Imbrium Basin (Fig.8).

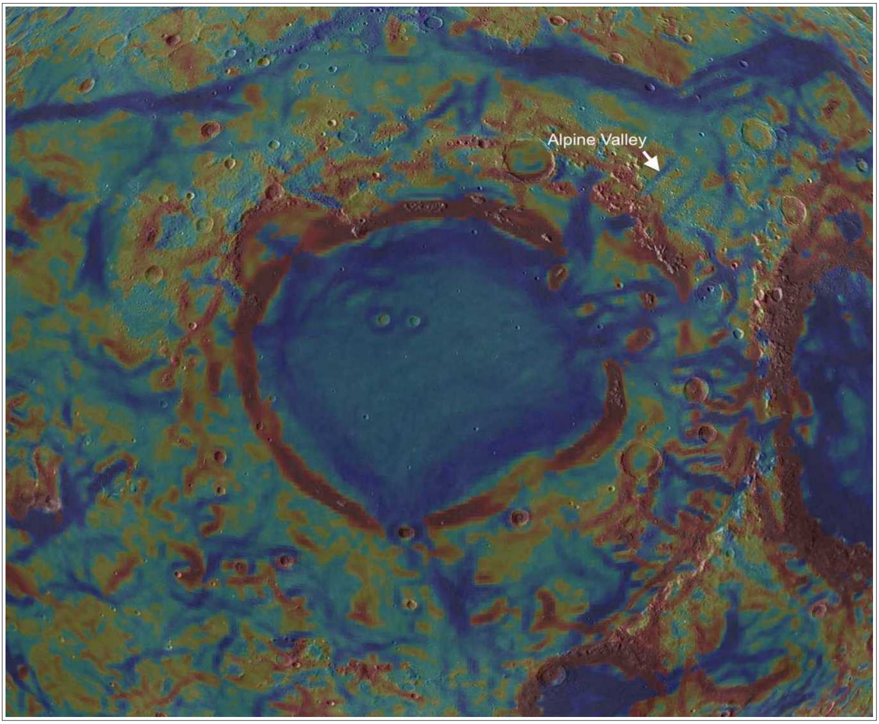

Fig.7 An LRO Quickmap rendition of the Imbrium Basin with the GRAIL 'Bouguer gravity gradient layer enabled. Note the gap in the inner ring (red circle) and the numerous almost-radial dyke like structures fanning out towards the north east. The one occupying the Alpine Valley is shown with a white arrow.

In the case of the Crisium Basin, it was suggested that Mare Marginis might represent terrain excavated downrange by the decapitated impactor[5] and this part of Mare Frigoris may be an analogous feature, with its location adjacent to Montes Alpes and along the proposed impactor trajectory possibly significant. It is also interesting to note that if this low lying tongue did not exist Mare Frigoris would in fact form a neat arc over the northern Imbrium Basin and not the odd looking eyebrow shape it makes now.

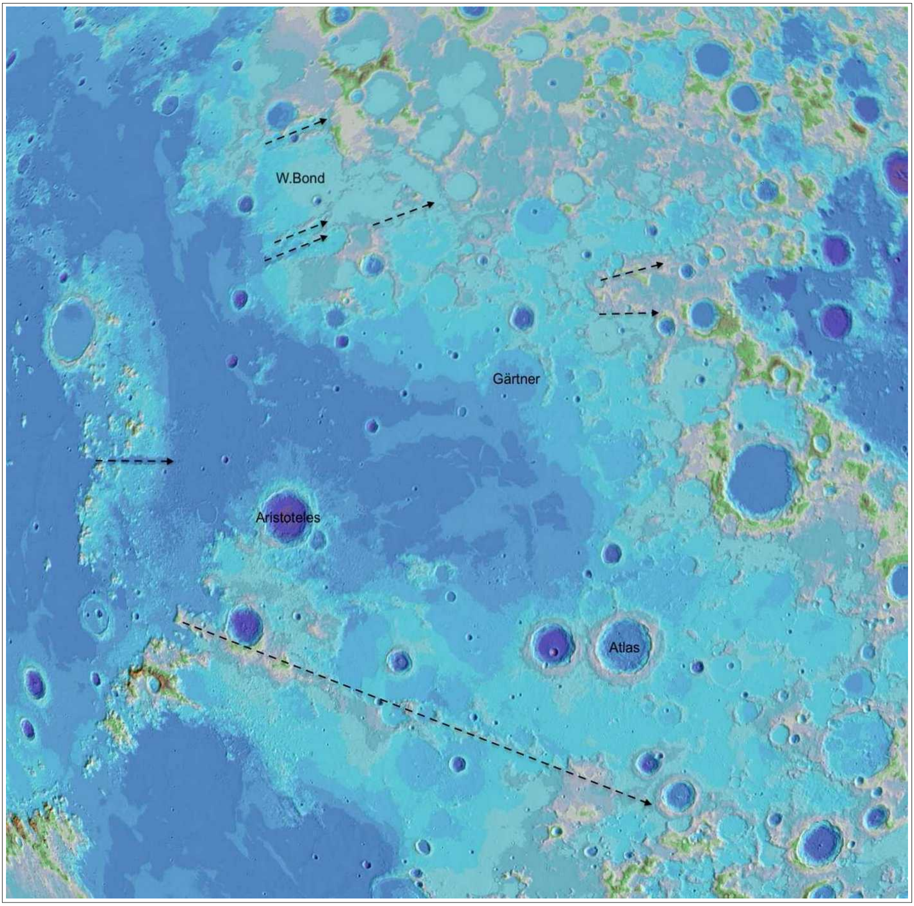

Fig.8 Colour Shaded Relief derived from the Global WAC digital terrain model (GLD100) showing features radial to Imbrium to the north-east (black arrows) and the low lying tongue like extension of Mare Frigoris which may represent a downrange surface excavated by a decapitated impactor.

The Apennines form the most conspicuous continuous rim like structure surrounding the basin, with the most elevated sections lying between Mons Bradley and Mons Ampère and with decreasing heights to the north and south. This corresponds to the down-range rim if one assumes the impactor arrived from the north-west. This might be somewhat unexpected as low angle impact structures tend to have a saddle shaped profile with depressed up-range and down-range rims and higher rims cross-range, the crater Messier being a good example of this type of configuration. If this situation applied to Imbrium, one might expect the height of the Apennine arc to increase towards the north and south, which would be the cross range directions in conformity with the saddle shaped profile, and not decrease as is the case. This may be a bit of a tenuous argument, and there are aspects of low angle impacts that might enhance the development of a down-range massif rim[9]but it is an observation that is consistent with the view that the impactor trajectory was from the south-west and the Apennines represent a *cross-range* rim and not a *down-range* rim. This would also account for the lack of a rim to the south-west, as this would represent the depressed *up-range* rim, and be more likely to be submerged beneath later lavas.

As has been noted above, the Imbrium Sculpture to the south-east, and particularly the 'non-radial' elements within it have been cited as being the result of the decapitation of an impactor arriving from the north-west[4]. To summarise, if you draw lines through the grooves and striations of the sculpture in an area such as that around Alphonsus, one set of lines will converge within 300kms of the basin centre, so *approximately* radial, whilst another set of lines will converge to the north-west of the basin, so *non-radial*. The *non-radial* set are suggested to have originated from the decapitated fragments of the impactor flying off downrange before the basin started to be excavated, whilst the *radial set* originated from material thrown out during basin excavation. These observations tally with laboratory observations, and if true would strongly support the north-west to south-east trajectory of the impactor. A glance at Fig.9 however shows that ejecta in a 'butterfly pattern' such as around Messier is also far from being radial to the crater centre, albeit in this case the crater itself is far from being circular in outline. If the Imbrium Sculpture to the north of the basin is also taken in to account one could be forgiven for seeing a 'butterfly pattern' emerging around Imbrium consistent with an impactor trajectory from south-west to north-east, and indeed some of the earlier attempts at mapping this sculpture produced distribution maps bearing a strong resemblance to such a 'butterfly pattern'[9].

In the north-west to south-east scenario, the area north of Mare Frigoris would be the up-range direction and consequently you might expect a suppression of the ejecta due to the 'Zone of Avoidance' effect. This area is however smothered in Imbrium ejecta which dominates the terrain immediately north of Mare Frigoris and takes on a 'dune like' morphology in areas like the craters J. Herschel and South. These features are likely to be similar in origin to 'dune like' topography around the Orientale Basin such as can be seen as up against the eastern rim of Riccioli. There is also no shortage of prominent Imbrium Sculpture and lineations to the north, elements which can be seen to the east of W.Bond and north of Philoalus G.

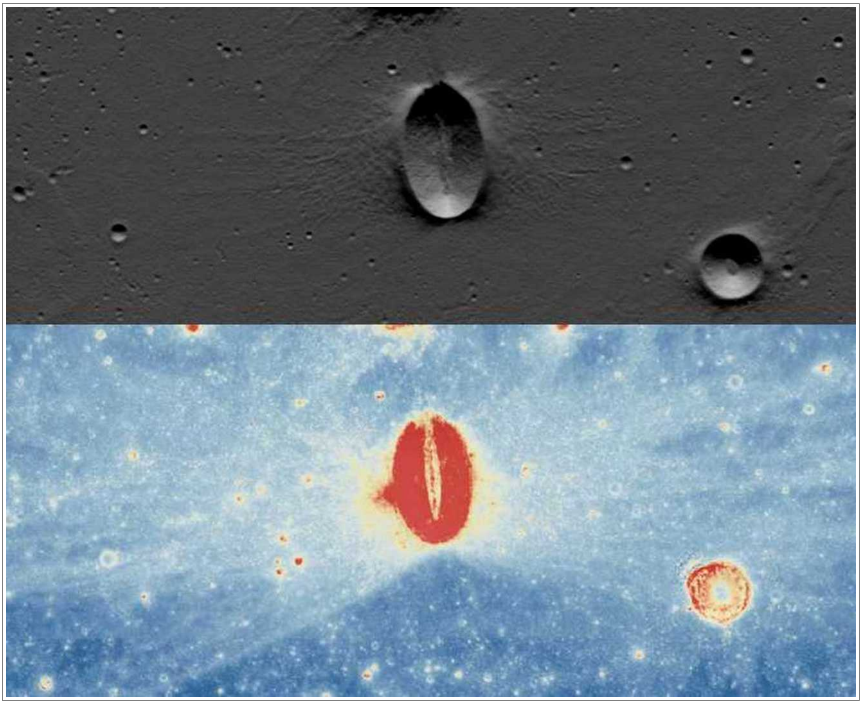

Fig.9 Two images of Messier, the top being a 'Terrain Hillshade' rendition and the lower being a SELENE/Kaguya Derived Optical Maturity (OMAT) overlay. Note that the features on each side of the crater (which include secondary crater chains) in the 'butterfly ejecta pattern' are not orientated radial to the crater centre but at much steeper angles which would, if traced back converge beyond the *opposite* rim. The same pattern can be seen in the OMAT image.

Also the eastern and western rims of many of craters such as J. Herschel, Babbage and South appear radial to the Imbrium Basin probably as a result of ballistic scouring by ejecta or as a consequence of basin radial faulting. So whilst these deposits and structures could well be components of a northern 'butterfly wing' ejecta pattern, it must be noted that the up-range terrain around the Orientale Basin is also heavily draped in ejecta, demonstrating that ejecta would not be out of place here if the conventional interpretation of Imbrium was accurate.

The absence of a basin rim to the north has been explained as being the result of it being "*unstable due to over-steepening*" and "*resulting in greater rim/wall collapse*" due to it being the up-range side of the basin[4]. This is a credible explanation, but the absence of the rim may also be due to its presumed location lying on a branch of the 'circum-Procellarum' rift system identified from GRAIL data and believed to represent huge crustal cracks that formed as a result of global contraction between 4.0 and 3.0 Gyr ago and which then formed the conduits for much of the near side mare lavas[10].

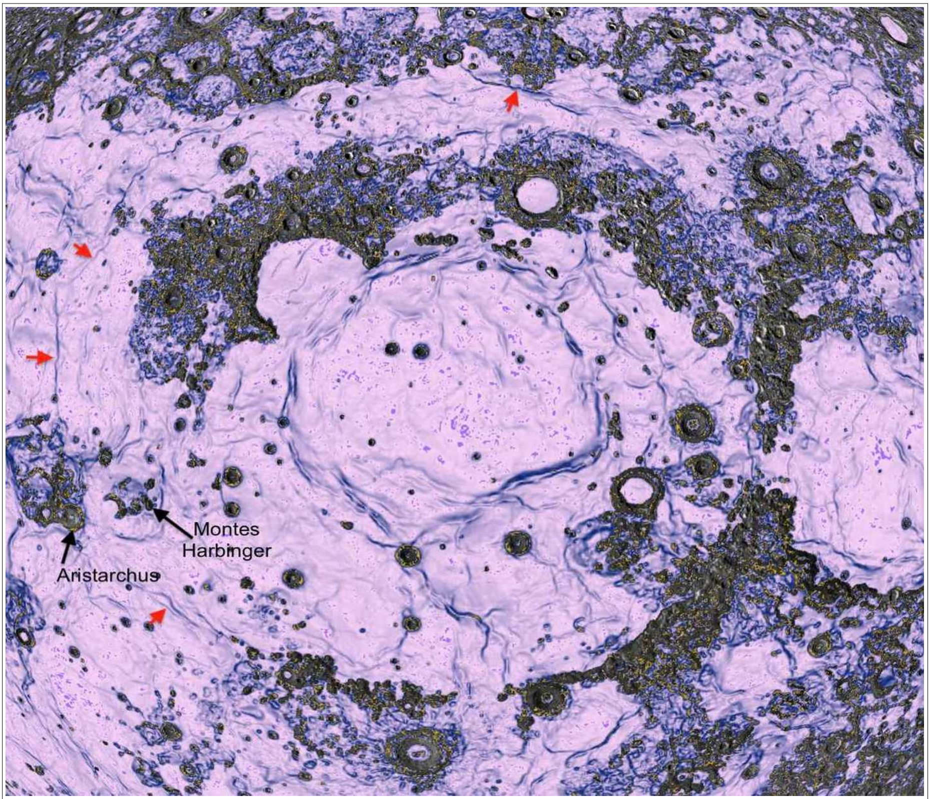

Fig.10 Quickmap rendition of the Imbrium Basin with a 'Terrain Slope derived from elevation data' layer enabled which shows subtle topographic features including a number of wrinkle ridges (red arrows) that combine with Montes Apenninus, Caucasus and Carpatus to define the possible rim of the basin.

This might account for the lack of a northern rim without recourse to the 'up-range rim' explanation. The former location of the rim may be visible in data such as that in Fig.10 which is a Quickmap rendition with a 'Terrain Slope derived from elevation data' layer enabled. This allows extremely subtle surface topography to be visualised, and as can be seen a number of wrinkle ridges form a fairly reasonable circular pattern along the arcs of Montes Apenninus, Caucasus and Carpatus. This possible 'ring' passes through the Aristarchus/Montes Harbinger area, which are significant volcanic centres, leading to the possibility that the ascent of the magmas associated with them occurred via fractures and faults that formed around the basin edge.

So, whilst there is considerable evidence that the Imbrium Basin formed by a low angle asteroidal impact from the north-west, there is also evidence to support an alternative view, where the impact responsible was from the south-west. In this latter scenario, the Imbrium Sculpture to the north and south of the basin would constitute a 'butterfly ejecta pattern' whilst features to the north-east including the Alpine Valley would represent features of the down-range ejecta pattern.

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LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME.
By Tony Cook.

TLP reports: No TLP reports have been received for February

Routine Reports received for February included: Alberto Anunziato (Argentina – SLA) observed: Alphonsus, Aristarchus, Censorinus, Eratosthenes, and Plato. Massimo Alessandro Bianchi (UAI) imaged: Mons Vinogradov. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine and imaged several features in visible light and the thermal IR. Walter Elias (Argentina – AEA) imaged: Alphonsus, Aristarchus, Copernicus, Eratosthenes, Mare Crisium and Plato. Valerio Fontani (Italy – UAI) imaged: Aristarchus, Copernicus, Montes Teneriffe, and Plato. Kris Fry (West Wales – NAS) imaged the lunar crescent. Les Fry (West Wales – NAS) imaged: De La Rue, Dorsa Aldrovandi, Endymion, Hercules, Montes Pyrenaeus, Palus Somni, Piccolomin, Posidonius and Theophilus. Leandro Sid (Argentina – AEA) imaged: several features and Vallis Schroteri. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus and Mare Crisium. Franco Taccogna (Italy – UAI) imaged: Montes Teneriffe, Plato, and Tycho. Aldo Tonon (UAI) imaged: Copernicus and Plato.

Routine Reports Received:

Note that time is unfortunately limited this month for a full analysis, so it will be left up to the reader to compare the original and modern-day observations:

Mare Crisium: On 2022 Feb 06 UT 18:40-18:55 Trevor Smith (BAA) observed this area under similar illumination to the following report:

On 1987 Feb 03 at 00:30UT J. de Carlo (Little Falls, NJ, USA, 4.5" refractor, x260, x350, seeing-very good) observed a very bright yellow light in the centre of Mare Crisium (near a raised crevice), almost like a "gigantic nuclear bomb explosion "which expanded (to 1/8th the diameter of Mare Crisium) and then reduced in size. The flare flickered at a rate of 1/10s. apparently the edge of this TLP looked *rough, almost like emitted debris. The TLP was fixed in position on the Moon. TLP confirmed by observer's father. The Cameron 2006 catalog ID=295 and the weight=3. the ALPO/BAA weight=2.*

The above is an interesting report and sounds almost like a dayside impact flash in terms of the colour, with a subsequent ejecta cloud? If so then the blackbody temperature would have been roughly equivalent to the surface of our yellow Sun or approximately 6000 K. However, we do not have much in the way of observations of dayside impacts. The only one I can think of is the Leon Stuart bright spot seen near Pallas crater in 1953, which hung around long enough to be photographed – though we do not know for sure that this was actually an impact event. The flickering may have been due to scintillation in our atmosphere? As for the expansion, 1/8th the diameter of Mare Crisium is about 50 km i.e., about twice the diameter of Proclus, no duration is given so we cannot determine a speed. The shrinking could simply be due to material fall out. Nothing obvious shows up on Clementine colour ratio images of this area, though the ejecta maybe to thin to show up in any imagery.

Not surprisingly, Trevor's observational report was simply: No yellow lights seen anywhere and nothing unusual was seen. All looked normal to me. We shall leave the original report at an ALPO/BAA weight of 2.

Censorinus: On 2022 Feb 08 UT 01:00-01:10 Alberto Anunziato (SLA) observed this crater under similar illumination to the following report:

On 1988 Nov 15 UT 19:15 Holmes (Rockdale, UK, 215mm Newtonian) noticed the Censorinus apron (just east of the crater and including the rim) was fuzzy but the crater was clear - a sketch was provided. A BAA Lunar Section observation. Cameron 2006 Catalog Extension ID=339 and weight=3. ALPO/BAA weight=2.

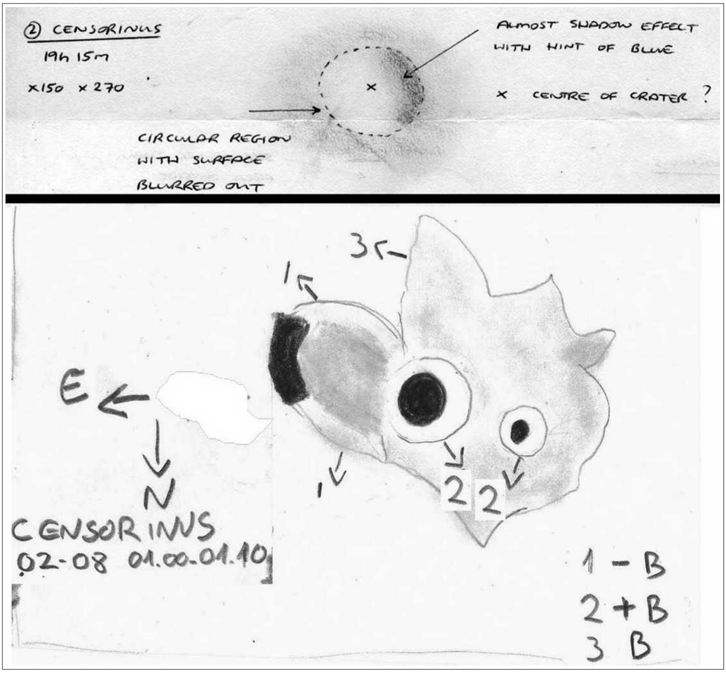

Figure 1. Censorinus in sketches and orientated with north towards the bottom. (Top) By Mark Holmes (BAA) from 1988 Nov 15 UT 19:15. (Bottom) From Alberto Anunziato (SLA) from 2022 Feb 08 UT 01:00-01:10, with visual brightness estimates added – note that the sketch has been corrected for its mirror reversed appearance.

Alberto, using a Meade EX105 scope at x154 noted that the ejection pattern was white, neat and bright. He provided a sketch (Fig 1 – Bottom) that can be compared to the original Mark Holmes sketch from 1988 (Fig 1 – Top). There appears to be quite a difference in appearance between Mark's and Alberto's sketches.

Tycho: On 2022 Feb 09 UT Franco Taccogna had a go at trying to capture the central peak of Tycho being illuminated by scattered light off the sunlit walls of the crater, despite being in a shadow filled floor. He took a sequence of images from 17:10-19:29 UT.

This is in response to a 2003 May 09 observation where Brendan Shaw (BAA) recorded the central peak, against the shadow filled floor, when the Sun was just +1.3° above the horizon – too low for direct illumination. We have since attempted this again at repeat illumination and the results have only occasionally replicated what Brendan recoded. Fig 2 (Left) is with a solar altitude of +0.8° and Fig 2 (Right) with a solar altitude of +0.9°. The +0.8° solar altitude has no sign of a central peak, but there is a slight hint in the +0.9° one, but it could easily be image noise.

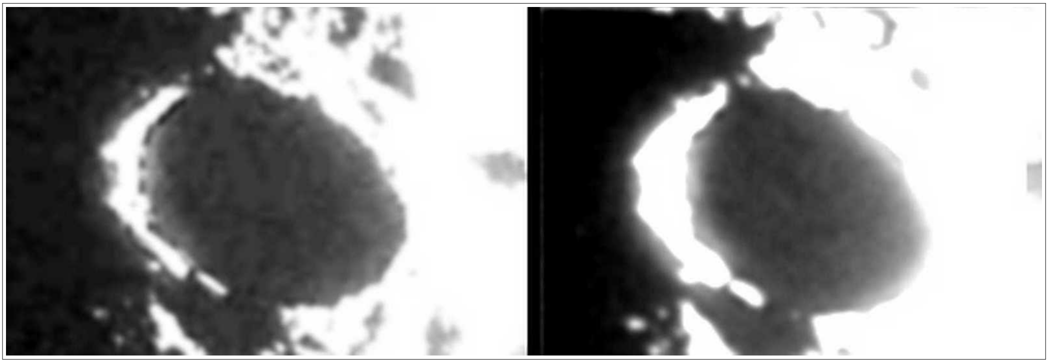

Figure 2. Tycho as imaged by Franco Taccogna (UAI) on 2022 Feb 09 UT 19:12 (Left) and 19:30 (Right). Both images have undergone contrast stretching and Gaussian blurring to reduce image noise.

Copernicus: On 2022 Feb 10 UT 17:44 Aldo Tonon (UAI) imaged this crater under similar illumination to the following TLP report:

2012 Sep 24 UT 22:00-23:00 Copernicus. E. Horner (Salisbury, UK, 15cm reflector) observed a prominent red arc where the sunlit part of the interior wall met the shadow. Sometimes the arc was 1/4 the way around the interior, and sometimes half of the way around. Telescope moved, but the red arc stayed where it was. Eyepieces change, but the effect remained. Other parts of the Moon checked, but no red seen. There were however splashes of green e.g., Longomontanus on the terminator, elsewhere further inland from the terminator, and little splashes of green on Mare Frigoras - but lasting a brief time. The red colour was as strong as a red LED and the green similar to that of the northern lights. The observer's husband was asked to independently check Copernicus and remarked that he could see a little bit of green at the top and some red near the bottom, along the line of the internal shadow. Although there were checks for red elsewhere on the Moon and none were seen, the Moon was starting to get low and it is typical of spurious colour in a few respects. Therefore, the ALPO/BAA weight=1 for safety.

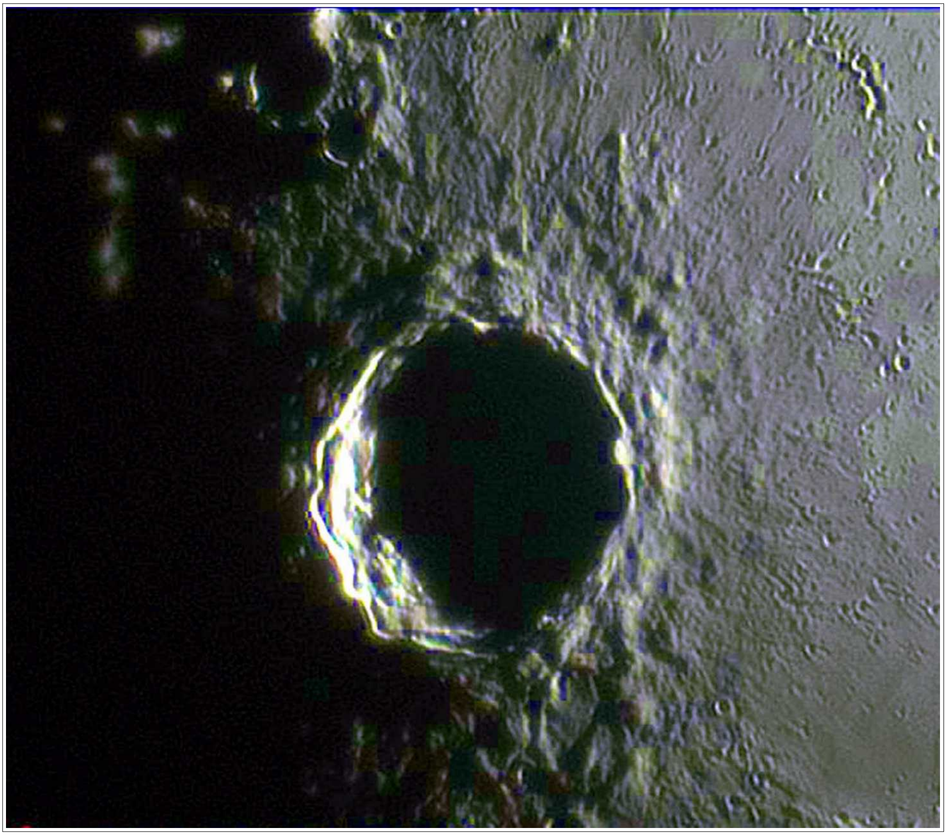

Figure 3. Copernicus as imaged by Aldo Tonon (UAI) on 2022 Feb 09 UT 17:44. Colour saturation has been increased to 85%. North is towards the top.

Despite a significant colour saturation increase, Aldo’s image (Fig 3) certainly does not exhibit the red arc as described by Horner. We shall therefore leave the original report at a weight of 1.

Eratosthenes: On 2022 Feb 11 UT Walter Elias imaged the crater under similar illumination to the following report:

On 1936 Oct 25 at 01:35 UT W. Haas (Alliance, OH, USA, 12" reflector) saw small bright spots on the floor of Eratosthenes,(Pickering's atlas 9A, col. 30deg, shows no spots - according to Cameron). Cameron 1978 catalog TLP=417 and weight=4. ALPO/BAA weight=1.

Figure 4. Eratosthenes as imaged by Walter Elias (AEA) on 2022 Feb 11 UT 01:33 and orientated with north towards the top.

As you can see from Fig 4 there are some white spots on the crater floor, but these are mostly peaks of the central peak area. There are hints of other white spots on the floor, but its difficult to say for certain.

Aristarchus: On 2022 Feb 12 UT 20:34, 20:53, 21:12 and 21:31 Valerio Fontani imaged the crater for the following Lunar Schedule request:

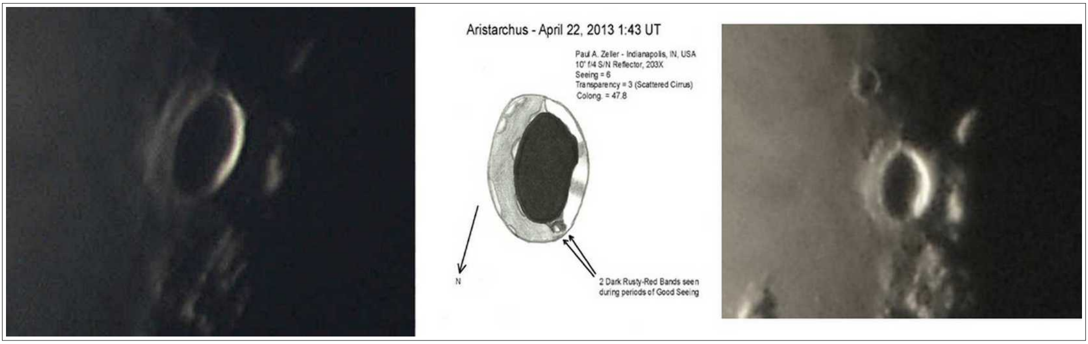

Figure 5. Aristarchus orientated with north towards the bottom. (Left) Image by Valerio Fontani (UAI) from 2022 Feb 12 UT 20:34. (Centre) Sketch by Paul Zellor (ALPO) from 2013 Apr 22 UT 01:43. (Right) Image by Paul Zellor (ALPO) from 2013 Apr 22 UT 01:43

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

Valerio's image (Fig 5 – Left) , although within the lunar schedule observing window, looks as though it is perhaps a little early in terms of colongitude to Paul's image on the Right. Although no bands are visible in either image, you can see that the northern most band that Paul drew (Fig 5 – Centre) corresponds to a dusky area on the NW rim of Aristarchus in Valerio's image.

The Full Moon: On 2022 Feb 16 UT 02:37 Leandro Sid (AEA) imaged the lunar disk as part of the Lunar Schedule request to monitor the brightness of different lunar features close to zero lunar phase angle. Some brightness's measured were as follows in order of dark to bright: Plato (61), Kepler (171), Copernicus (174), Tycho (211), Aristarchus (213), Proclus (214), Censorinus (239), Bright Spot near Hell (250).

Mons Vinogradov: On 2022 Feb 16 UT 21:21-21:22 Massimo Alessandro Bianchi imaged this area, under similar illumination to the following report:

On 2006 Jan 16 at 05:44UT T. Bakowski (Orchard Park, NY, USA) observed a round dark object in 1 of 21 frames from a camera. The exposure was 1/250th sec. Seeing conditions were bad. The dark spot is east of Mons Vinogradov, at or near crater J. ALPO/BAA weight=1.

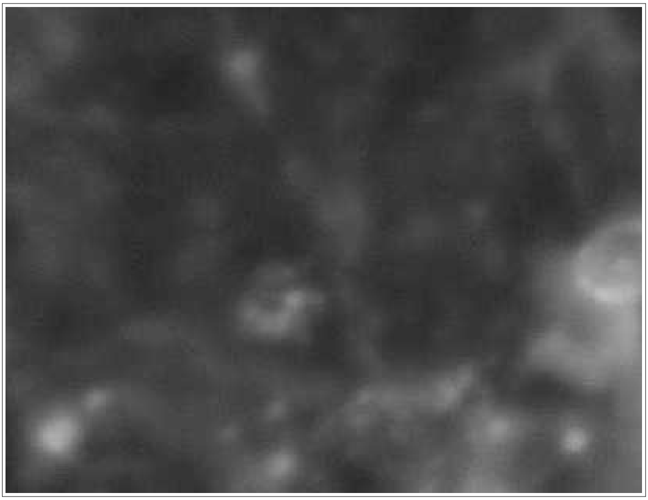

Figure 6. Mons Vinogradov as imaged by Massimo Alessandro Bianchi (UAI) on 2022 Feb 16 UT 21:21 and orientated with north towards the top.

I had a look in the archives to see if I could find an image of what T. Bakowski had imaged, but alas all I could find was an email forwarded onto me from the observer by ALPO's lunar impact flash observer, Brian Cudnik. There was a link in the email to a video sequence, but as it was 16 years old, the link no longer works and I could not find it in the Internet Archive (https://archive.org/web/) either. On the plus side we now at least have Massimo's image (Fig 6) of what the area normally looks like and can confirm that there is no dark lava pond east of Mons Vinogradov which might have shown up nice and sharp, during a good moment of seeing, in one of the original video frames. Almost certainly what we had back in 2006 was probably a bird or bug flying across the field of view and appearing dark against the bright lunar disk. As it was flying fast it would appear in just one of the frames from the video sequence. As exposure at Full Moon is short, due to the Moon's brilliance, any object getting in the way does not have to be motion blurred. To illustrate how common it is to have objects in our atmosphere passing across the Moon, during March this year, from the UK I saw several dark migrating birds crossing the line of sight to the Moon when I was observing with a thermal imaging camera! Birds are very well insulated, and so appear dark in the thermal IR compared to the heat of the lunar surface. Even if I had been observing in the visible light, then they still would have appeared dark due to the silhouette effect against the lunar surface!

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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