Acting Director: Anthony Cook.
Editor: Barry Fitz-Gerald.

LUNAR SECTION CIRCULAR

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EDITORIAL.

2022 will be an interesting year spaceflight wise. At the time of writing, the delayed Artemis 1 mission is supposed to launch to the Moon, without a crew in order to test out the rocket and command and service modules, prior to a manned orbital flight the following year. This may be in March but could slip to the Summer. To take advantage of this opportunity ten lunar CubeSats, will be deployed to map water, hydrogen and perform other lunar science.

For us as amateurs it may be a great opportunity to track the massive Space Launcher System (SLS) rocket on the way to the Moon. 2022 may see several robotic landers hopefully touch down on the Moon too. Japan's OMOTENASHI will try to demonstrate a higher velocity than normal hard landing using air bag technology. Intuitive Machines will attempt to place a lander with 100kg of payload into Vallis Schroteri. In July Russia will launch Luna 25, possibly to land north of Boguslavsky crater at 69S. In December three landing missions will be attempted: Prime 1, which will attempt some drilling, Peregine which will land in Lacus Mortis (possibly near a skylight), and Japan's SLIM lander whose purpose is to perfect accurate robotic landing techniques. Korea will launch a Pathfinder Orbiter mission in July with a polarimeter camera.

I wish you all a happy 2022, let us hope that it will be an improvement over the last two years. Also, if you have not already done so, don't forget to try out some of the scheduled observing targets on the Lunar Schedule web site you might find these interesting, though please check back from time to time as I will be iteratively adding additional repeat illumination targets, from old sketches published in the Moon.

Tony.

CORRESPONDENCE RECIEVED:

In response to: ***Will Future Lunar Satellites Interfere with Earth-Based Observations of the Moon?by Keith Burrel.***

With regards the Andromeda micro satellite proposal, given that a reflection can have a greater impact, and be far more noticeable than you would expect, for the size of the object doing the reflecting, it may produce an increase in TLP reporting perhaps with people with larger scopes, and certainly may interfere with your work of TLPs in the earth-lit side of the moon, possibly?

Bob Stuart.

Director Comment: It is possible that it might trick the inexperienced, but would have to be seen against earthshine or the weakly illuminated terminator region to be visible. Undoubtedly there will be predictions of the satellite positions, so we can rule these out as TLP quickly.

Lunar Fake News From 200 Years Ago.

The Journal of the Society for the History of Astronomy mentions in their last issue that newspapers of the 1820s reported observations of the Moon telling that a colossal building situated near the equator of the Moon resembled a fortress with straight ramparts, and that vegetation existed from 50 degrees north to 37 degrees south.

John Rosenfield.

Director Comment: Based upon additional information that John sent me, the interesting article was published in the Society for the History of Astronomy, 36, Autumn 2021, by David Bryden: Humanoid Inhabitants of the Moon in the 1820s: Hoax, Satire, or Wishful Reading of the Visual Audience? It discusses the precursors to the lead up to the falsification that Sir John Herschel had seen humanoids on the Moon in 1835, attributed to Richard Adams Locke, publishing in the Sun newspaper in New York. The precursors being Gruithuisen's lunar city which he thought was near to Schroter crater, and other events/stories from around that era. There was a nice paper by Richard Baum about Gruithuisen in the BAA Journal, Vol 102, from 1992 p157 & 159. Though for the more modern take see the Journal for the History of Astronomy, mentioned above.

Errata

Apologies to James Dawson. In the December 2022 LSC we presented an Albategnius image, having copied it from his BAA members web site. Although the left hand image was his, the right image was actually a Lunar Reconnaissance Orbiter product – something he comments he would not have been able to achieve in terms of resolution from Nottingham. The text of the right image said it was taken on 2020 Nov 28, but this turns out to have been the upload date for the animated GIF on his website, and should have been 2021 Nov 20.

OBSERVATIONS RECEIVED:

Observations have been received from the following:
Leo Aerts (Belgium), Massimo Alessandro Bianchi (Italy), Klaus Brasch (USA), Rik Hill (USA), Bob Stuart (UK), Trevor Smith (UK) and Alexander Vandenbohede (Belgium).

APOLLO 15 LANDING SITE.

Fig.1 The Apollo 15 landing site under matching illumination to when Apollo 15 touched down. Taken by Massimo Alessandro Bianchi using a Vixen VMC260L Maksutov Cassegrain f/11.5 telescope with a ASI 178MM CCD and a Baader G filter.

This is what the Rimma Hadley area would have looked like through a telescope (ignoring libration) when the Apollo 15 mission landed on the Moon on 1971 Aug 07. Three UAI observers: Massimo Alessandro Bianchi, Valerio Fontani, and Aldo Tonon, attempted this Lunar Schedule request.

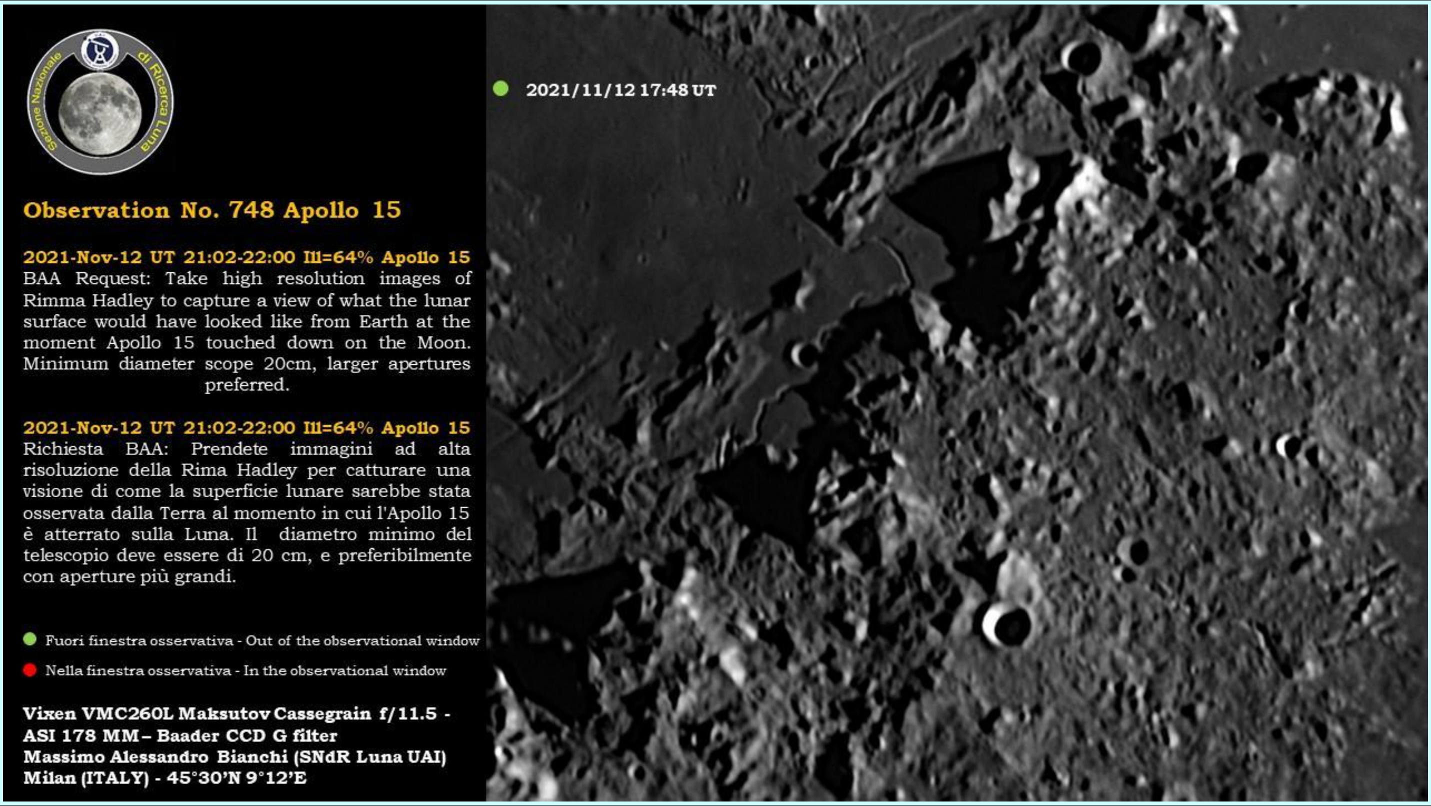


Fig.1 Apollo 15 Landing site by Massimo Alessandro Bianchi

A TALE OF TWO MARE.

Fig.2 Mare Crisium and Mare Marginis as imaged by Rik Hill, Dates and UTs given in the image. This montage was made from five, 1800 frame AVIs stacked with AVIStack2 (IDL), assembled with MicroSoft ICE and finally processed with GIMP and IrfanView.

Comment by Rik Hill:
This is a much larger portion of the moon and higher sun than I usually do but it shows some seldom seen features well thanks, to a favourable libration. Of course, the "elephant in the room' is Mare Crisium (638km dia.) on the left side of the image with the bright rayed crater Proclus (29km) on the west side (left) of the Mare. On the south edge of this image is dark floored crater Firmicus (58km) and next to it are the northern fingers of Mare Undarum. Move back towards the southern edge of Crisium you will see a large crater with a floor that is half dark. This is Condorcet (77km) with Hansen (41km) just to the right or east of it. Notice the backwards "3" just outside the upper right edge of Crisium. This is Mare Anguis (130km x 30km). It's listed as 134km diameter but is anything but circular! Totally unassociated but south of this and further east of Crisum is another bit of mare material of the same shape and orientation as Anguis. Curious but no more than that. However, it leads us to the larger patch of mare material that is Mare Marginus, not usually seen this well. On the south end of this mare you can see most of the northern two thirds of the large dark floored crater Neper (141km) with its bright central peak. Note on the opposite side of Marginis, on the north side there is a very oval dark feature that is the crater Goddard (92km). Then further north, well outside Marginis, is another dark floored crater Hubble (83km). On the limb north of this is our last crater, Liapunov (68km) visible only at favourable librations like this one.

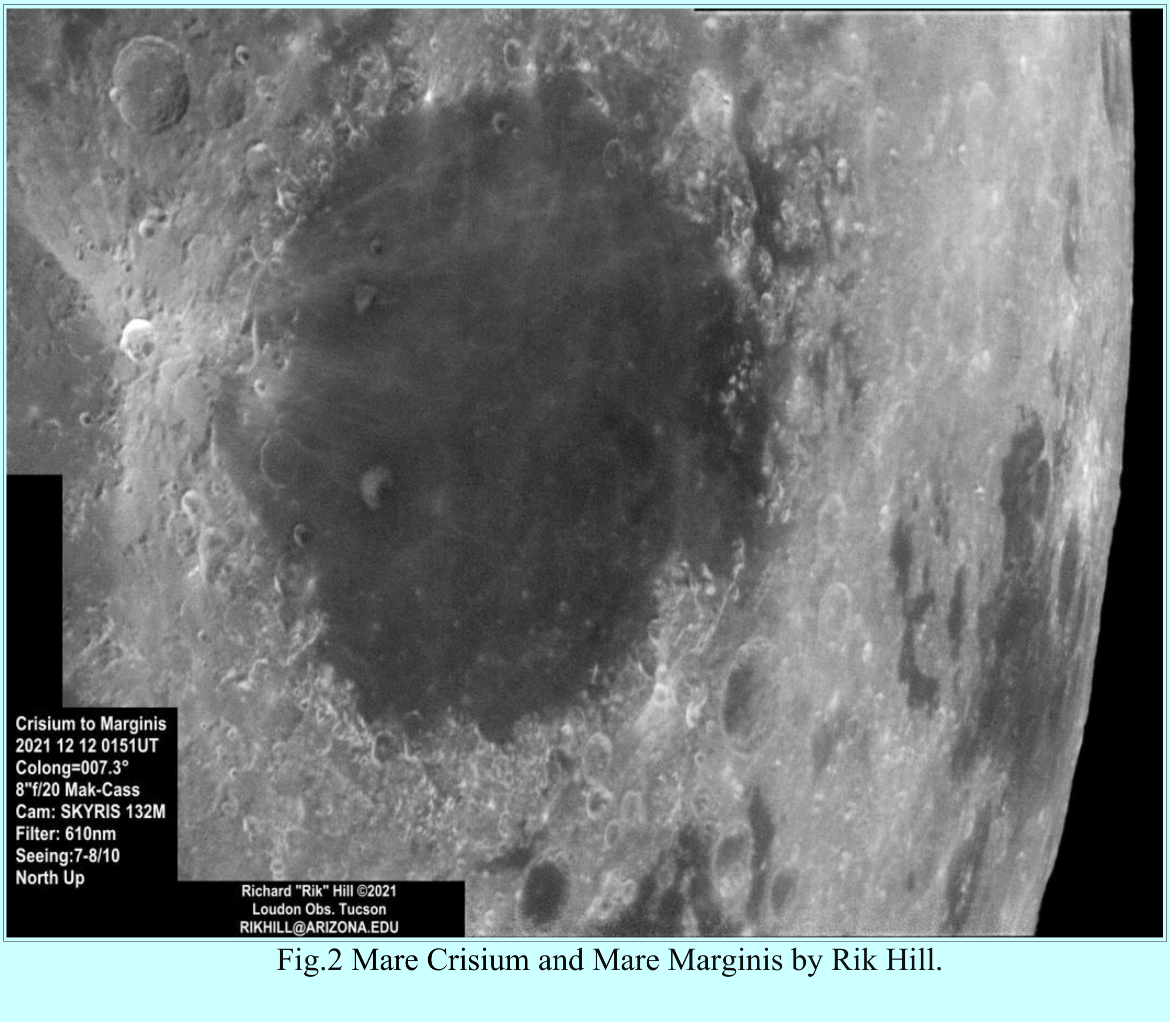


Fig.2 Mare Crisium and Mare Marginis by Rik Hill.

DELAMBRE AND SINUS ASPERITATIS.

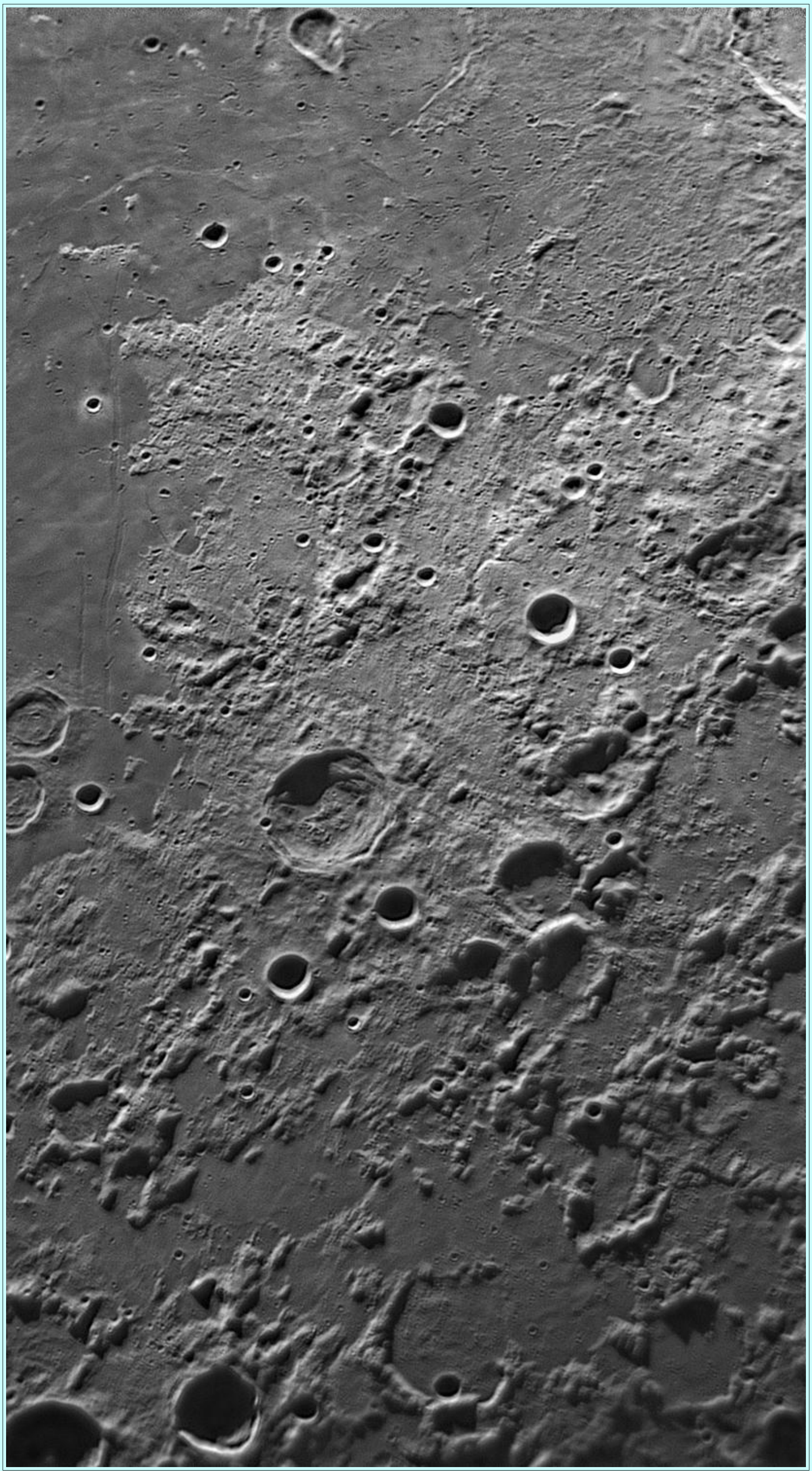


Fig.3 Delambre and Sinus Asperitatis as imaged by Leo Aerts on 2021 May 18 UT 17:50. A red filter and an ASI 290MM webcam was used. Image tilted with north towards the left.

Director Comments: Leo notes that he was trying to mimic spacecraft images with his C14 scope! It just covers the Apollo 11 landing site on the left edge. Just for scale Delambre is 52 km in diameter.

PLATO.

Figs.4a-b A visual observation made of Plato by Trevor Smith on 2017 Mar 06 UT 17:20-21:10 with a 16” f/6 Newtonian, with a x247 Plössl. Seeing was Antoniadi III-IV.

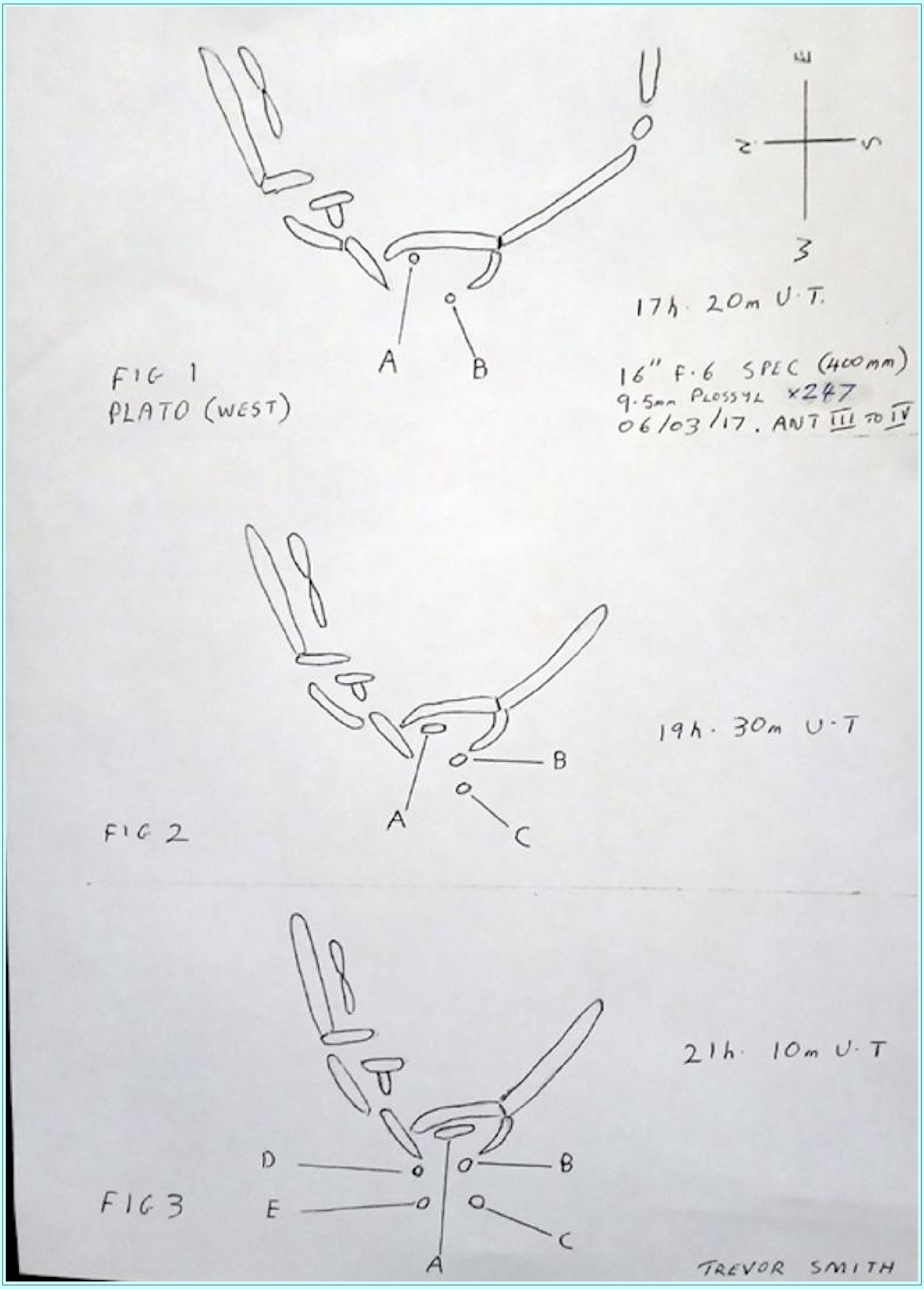


Fig.4a Drawings of Plato by Trevor Smith

PLATO WAS A SPLENDID SIGHT AS IT SAT DIRECTLY ON THE LUNAR TERMINATOR.
THE EVENING WAS QUITE WARM WITH NO BREEZE AND NOT A SIGHT OF ANY CLOUDS IN THE SKY.
PLATO HAS ALWAYS BEEN ONE OF MY FAVOURITE OBJECTS AND IS ALWAYS A PLEASURE TO LOOK AT. TONIGHT, IT SAT IN ALL ITS SPLENDOUR DRAWING THE EYE TO ITS MAJESTIC CONTOURS.
THE WESTERN RIM WAS BROKEN BY THE TERMINATOR INTO A DOZEN OR SO INDIVIDUAL SEGMENTS. THE EXTREME WESTERN PART OF THE CRATER WAS STILL NOT TOTALLY SUNLIT AND THE FAMILIAR TRIANGULAR SLUMP OF THIS REGION WAS ONLY JUST COMING INTO VIEW.
THIS 'SLUMP' ALWAYS REMINDS ME OF AN INSECTS JAWS. LOOKING INSIDE THESE 'JAWS' A FAINT WHITE SPOT/PEAK WAS JUST COMING INTO VIEW (SEE FIG 1). THE TIME WAS 17h 10m U.T THIS SPOT WAS ONLY JUST GLIMPSED AT TIMES AND IN MOMENTS OF WORSE SEEING IT DISSAPEARED ALTOGETHER. AS I WATCHED AND THE MINUTES PASSED THIS SPOT SLOWLY BRIGHTENED AND BY 17h.28m U.T IT COULD BE SEEN WITHOUT ANY DIFFICULTY.
A FEW km TO THE WEST, ANOTHER VERY FAINT WHITE PEAK (B IN FIG 1) WAS GLIMPSED. THIS WAS FIRST SEEN AT 17h.20m U.T AND BY 17h. 28m THIS PEAK WAS ALSO SEEN WITHOUT DIFFICULTY.
BY 19h.25m U.T THE FIRST PEAK, (I DESIGNATED A FIG 2) WAS BECOMING QUITE ELONGATED IN A NORTH TO SOUTH DIRECTION THE PEAK DESIGNATED B IN FIG 1+2 WAS NOW VERY BRIGHT AND LARGER IN SIZE.
A FEW km FURTHER TO THE WEST A NEW SPOT/PEAK WAS BECOMING VISIBLE. BY 19h.30m U.T THIS PEAK WAS VERY EASY TO SEE. I DESIGNATED THIS AS C IN FIG 2 + 3.
BY 21h.10m U.T TWO MORE PEAKS HAD JUST EMERGED OUT OF THE DARKNESS OF THE TERMINATOR. I CALL THEM D + E IN FIG3. THEY WERE JUST A FEW km TO THE NORTH OF B + C.
OBSERVATIONS HAD TO STOP AT 21h.10m U.T DUE TO THE MOON BECOMING HIDDEN BEHIND A NEIGHBOURS TREE!

Fig.4b Notes on Plato observation by Trevor Smith

Director Comments: Trevor Smith has sent in a description that he made of Plato some years ago now, but I wanted to include it ***(a)*** *because it also shows how valuable visual and descriptive observations still are, and* ***(b)*** *because it illustrates how the floor of this crater can change so rapidly in appearance over a short space of time.*

MARE MARGINIS SWIRLS.

Fig.5 Mare Marginis as captured by Alexander Vandenbohede on 2021 Dec 16 UT 18:35. (Left) Original image. (Right) Map projected to remove limb distortion. Taken with a C8, 1.5x Barlow, red filter and ASI290MM. Libration was favorable for the observation (0°51’ in latitude, 2°16’ in longitude) although the size of the lunar disk was rather small (29.78’).

Director Comments: Alexander notes that the targets of the observation were the lunar swirls that occur in the region. It is very hard to see them on the image. Therefore, he rectified it, and this showed the swirls very well. There are for instance different examples west and south of the crater Goddard. There is an especially bright one southwest of Goddard. There are some further examples north of the crater Neper. Swirls are albedo features which often overlay local magnetic fields that are able to deflect solar wind particles some of the time, so the surface has less space weathering. Why they do this is still a mystery and oddly there is no compositional difference across the swirls and no topography that matches the swirl shape.

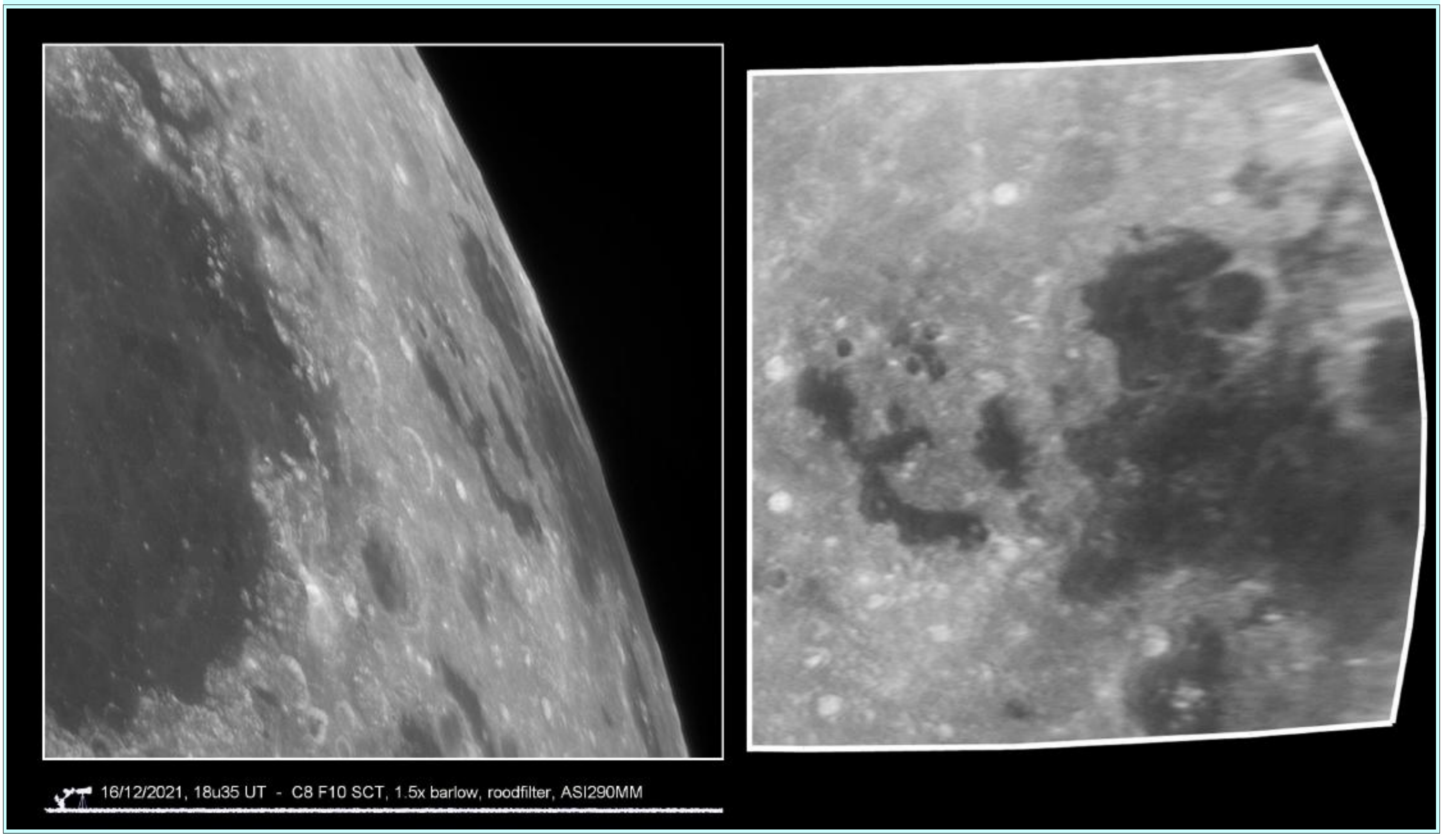


Fig.5 Mare Marginis by Alexander Vandenbohede

THE MOON JUST PAST FIRST QUARTER.

Fig.6 The Moon just after first quarter as imaged by Klaus Brasch on 2021 Nov 11.

Fig.6 Image by Klaus Brasch

Directors Comments: Klaus mentions that although he cannot hope to measure up his friend Leo Aerts' standards of imaging, he was curious to see just how detailed an image is possible with one of his favourite small telescopes, aTMB-92 f/5.5 Signature Series apochromatic refractor, designed by the late Thomas M. Back. Klaus was not disappointed. This Nov. 11, 2021 image is a mosaic of several stacked frames taken with a ZWO ASI120 MC camera in monochrome through a deep red filter under only moderate seeing conditions from his observatory in Flagstaff, Arizona.

BIRT AND RUPES RECTA

Fig.7 Birt and Rupes Recta as imaged by Bob Stuart on 2021 Aug 29 at 04:38 UT. 25cm f6.3 Newtonian, 5x PowerMate, Baader yellow filter, ZWOI 174MM

Director Comments: Bob says the article on double impact craters and the zone of avoidance and the path (trajectory) in the 2021 Dec LSC allowed him to compare an image that he took in August, of Birt, with the image in the newsletter. It shows a fair bit of detail shown in the lunar orbiter image (though illumination is opposite), and also shows the ZoA (Zone of Avoidance) quite well.

A SELDOM SEEN MAP OF THE MOON.

by Nigel Longshaw.

Through the kindness of Richard Baum I received several lunar books from the collection of Harold Hill when he sadly passed away in 2005. Tucked inside a rather battered copy, clearly well used by Harold, of the Kwasan Observatory, Photographic Atlas of the Moon, Second Edition, 1964, was a small map of the Moon. Mounted on card, and clearly of a much earlier date that the atlas in which it was kept. The condition of this small map was not very good, having been torn in two at one stage, but sufficiently important to Harold for him to have sellotaped the two halves together (Figs.1 and 2).

Fig.1

Going through these treasures before he passed them on to me Richard commented that he had not seen a copy of this particular map of the moon before and wondered how it had found its way into Harold's possession. I did not think too much of it at the time, the map was of very small scale, and appeared to be simply a general map of the lunar surface, perhaps suitable for use at the eyepiece of a small telescope to familiarize the observer with the general features of the lunar surface.

On several occasions since I have perused this map and wondered about its origin. A small inscription on the lower part of the map reads ‘By permission of Messers Horne and Thornthwaite, 416 Strand’. This was not a name I was particularly familiar with in terms of close connections with lunar studies, but one which must have stuck in my mind as I recalled it recently whilst undertaking research on the internet into another subject.

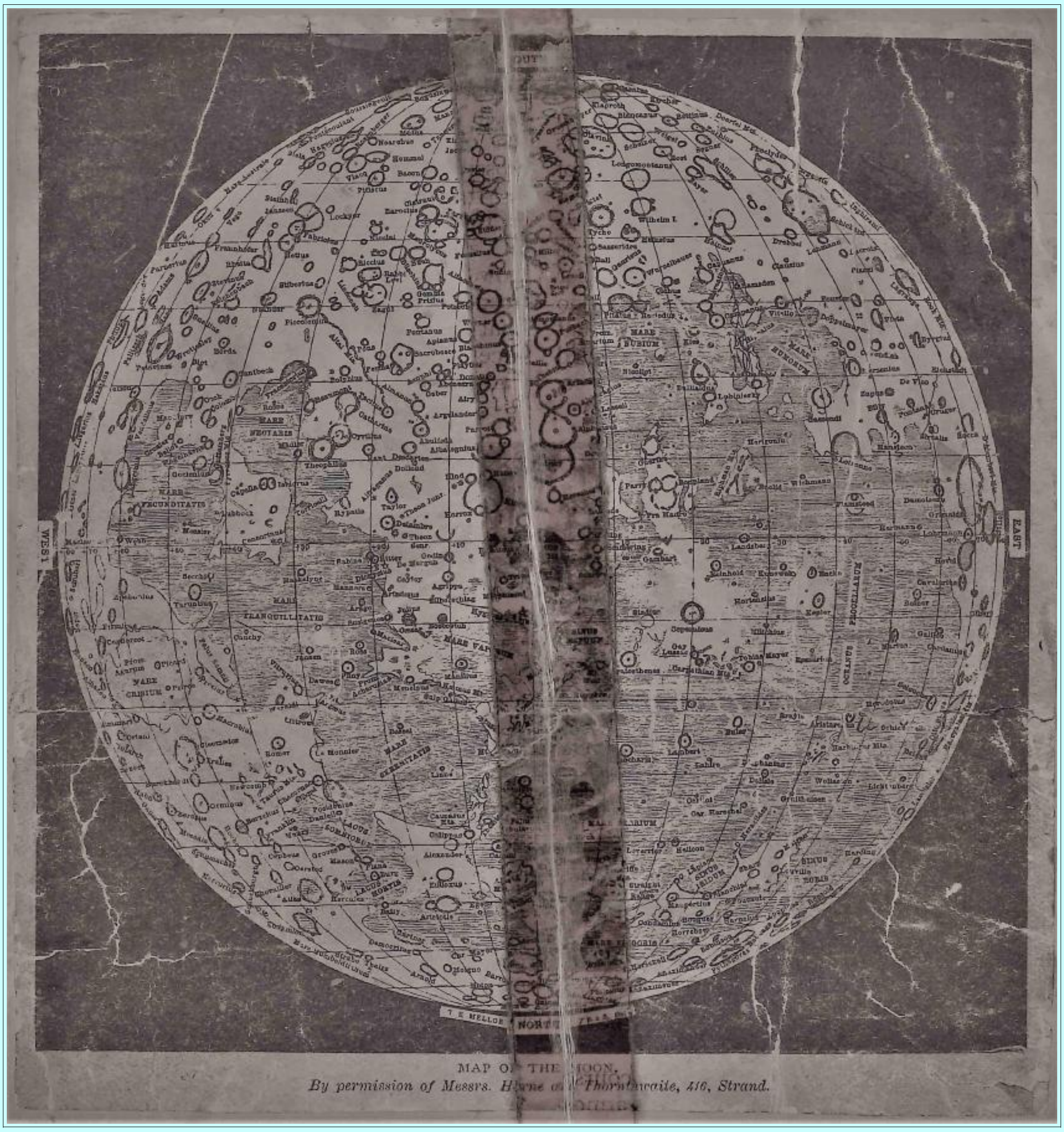


Fig.2

Ewen Whitaker (1922-2016) will be a name familiar to many interested in Lunar Studies. From a long and illustrious career Whitaker’s collected papers and books are now catalogued online, accessible via the Arizona Archives Online site. Reading through the contents of Whitakers archive I came across an entry under ‘Series X: Maps and Drawings, 1805-2000, box 45, folder 7, which read ‘The Handy Map of the Moon, Horne, Thornthwaite and Wood, 2 prints on board, circa 1886’. Surely this could not be any other than the Horne and Thornthwaite attributed to my small map of the Moon?

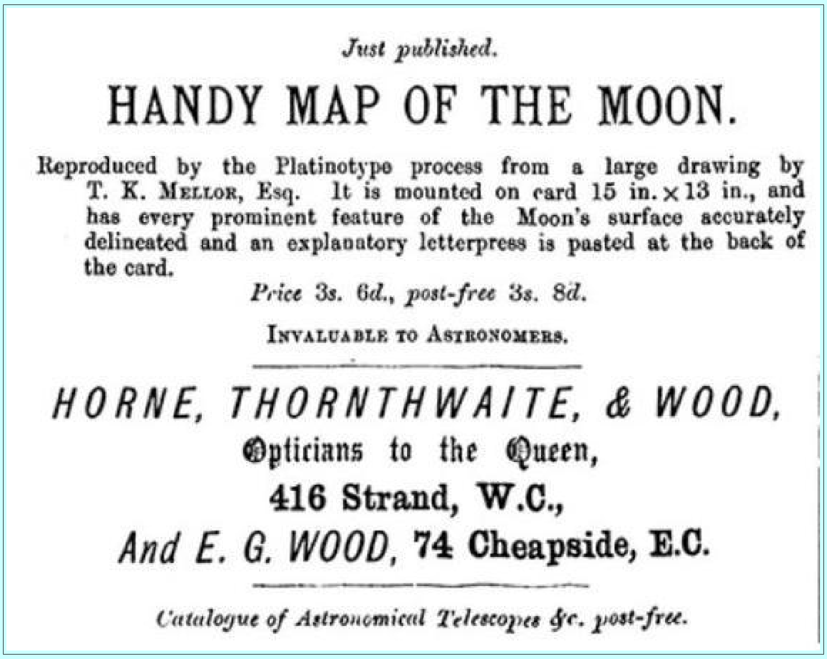


Fig.3

A further search of the internet revealed that several businesses were set up by Messers, Horne and Thornthwaite, with a third partner E.G.Wood, over a period of 67 years between 1844 and 1911. Initially the three men, Fallon Horne (1814-1858), William Henry Thornthwaite (1819-1894) and Edward George Wood (1811-1896) worked for Edward Palmer who operated a scientific supply shop in London. When Palmer retired in 1844 the stock was bought by Horne, Thornthwaite and Wood. Sons of both Thornthwaite and Wood became partners over time and in 1890 the business was bought by two employees, John and Thomas Overstall, both brothers joined the BAA in 1894. There is a fascinating history of the companies set up by these men and their mixed fortunes on the internet for anyone who would like to delve deeper into their activities.

Essentially the businesses in all their guises dealt with the sale and manufacture of microscopes, cameras, telescopes, other optical equipment, chemicals, and laboratory supplies. In addition, they supplied sundry items such as photographic plates, lantern transparencies, and microscope slides. In 1886 the company advertised the 'Just Published' Handy Map of the Moon (Fig.3). The map was, as advertised, 'Reproduced by the Platinotype process from a large drawing by T.K.Mellor Esq. It is mounted on card 15in x 13in. and has every prominent feature of the Moon's surface accurately delineated and an explanatory letterpress is pasted at the back of the card'.

The two copies of the card mounted maps in the Whitaker archive are most probably originals of this 'Handy Map of the Moon'. As for my own copy, it is rendered at a much smaller scale and as it is noted being reproduced with the permission of Horne and Thornthwaite, this suggests perhaps a reproduction for inclusion in another publication or periodical of the day perhaps to illustrate an article about the Moon.

For those who might never have heard of this map, let alone seen a copy, I attach scans of the original map (repairs and all!) along with an attempt to get the best out of the reproduction with a little editing to the original scanned copy. I also include an extract of the original advertisement for the 'Handy Map of the Moon'. I wonder how many of these maps have survived, I have only ever seen the one copy in my possession. I would be interested to hear of anyone who might have an original full-size copy of the 'Handy Map'.

All in all, despite its obvious age, the map does provide a handy little reference for the small telescope or binoculars – if your eyesight's good enough to read the text!

Lunar Domes (part LIV): Investigating lunar domes in Arago region and in Mare Spumans
By Raffaello Lena

In this contribution I provide an analysis of some recent images submitted by Maximilian Teodorescu and Frank Schenck regarding the domes in Arago region and in Mare Spumans.

Arago is a well-known crater located in the western part of Mare Tranquillitatis. Mare Tranquillitatis is situated on the site of an ancient pre-Nectarian impact basin [1-2]. As reported in [3] the older lavas in Mare Tranquillitatis are characterized by a lower Titanium content (reddish in colour ratio), while the youngest lavas erupted in the region are blue (higher Titanium content). The Arago region has been described in my previous note [4]. As shown in Fig. 1 three low domes, located to the north of Arago, are aligned. These three aligned domes, named as A4-A6, have base diameters of 11.1, 8.4 and 9.5km respectively. The height amounts to 65±10m for A4, 50±5m for A5 and 45±5m for A6, yielding flank slopes of 0.7° (A4) and 0.6° (A5-A6).

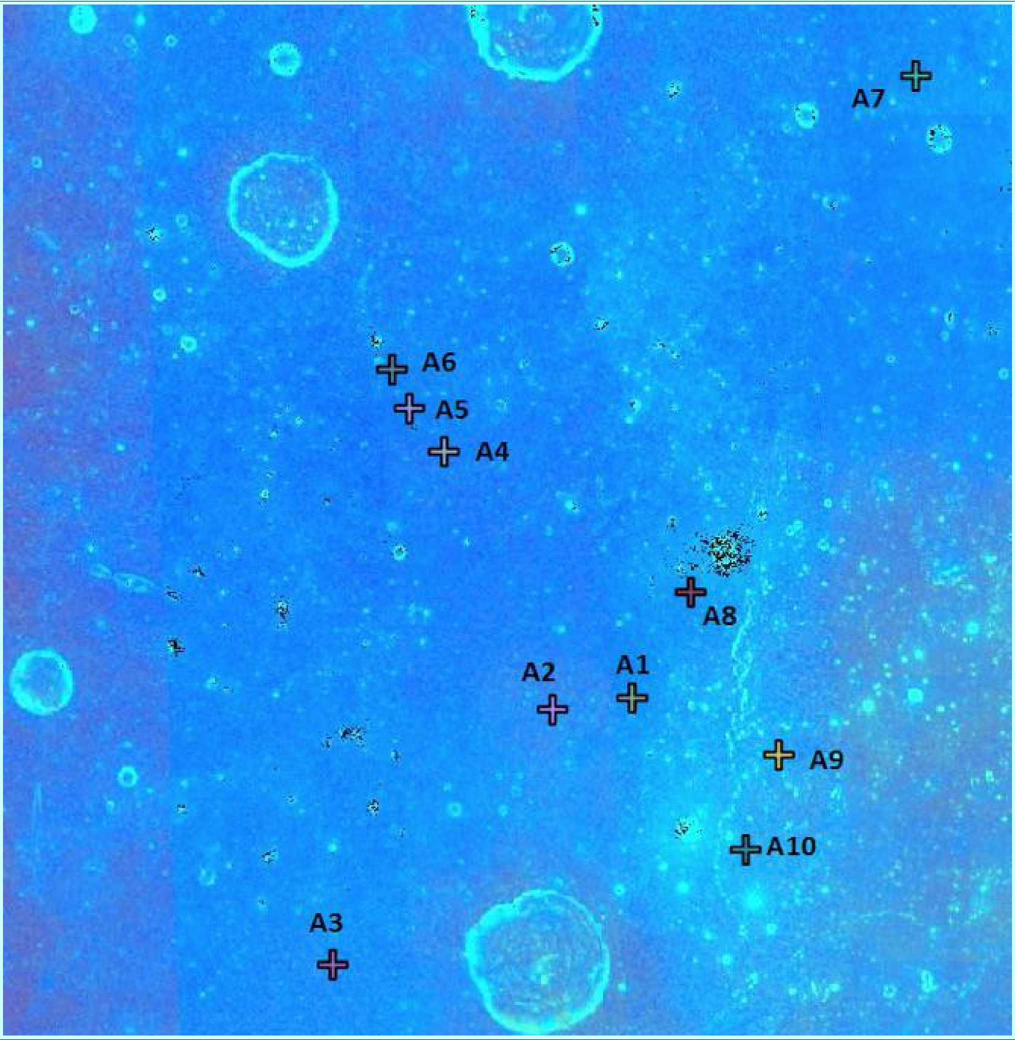


Figure 1: Clementine color ratio imagery of the Arago region including the lunar domes. The domes A1-A10 are described in a previous LS circular by the author [4].

An excellent image of this region is shown in Fig. 2. The image was taken by Teodorescu on November 25, 2021 at 03:49 UT using a 355 mm Newtonian telescope. As very low solar illumination angles are required to reveal the gentle slopes of lunar domes, the subtle domes A4-A6 in the probes imagery are not prominent (Fig. 3) as in the telescopic image shown in Fig. 2 taken under oblique illumination.

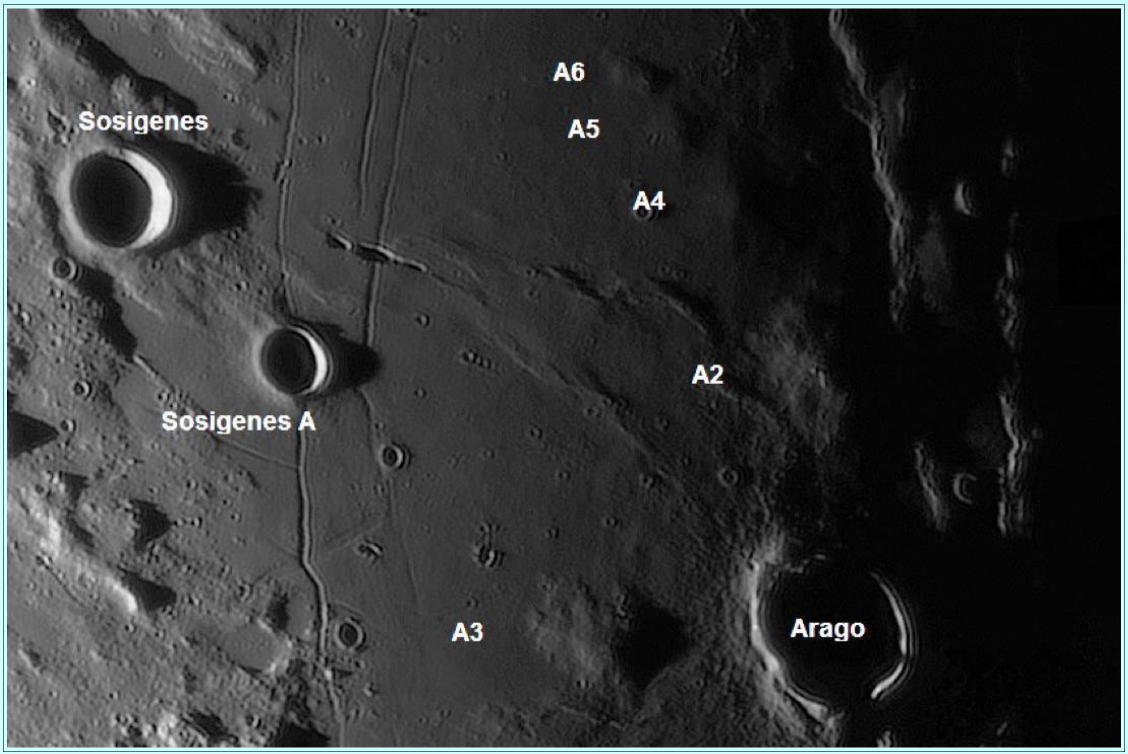


Figure 2: Telescopic image made by Teodorescu on November, 25 2021 03:49 UT.

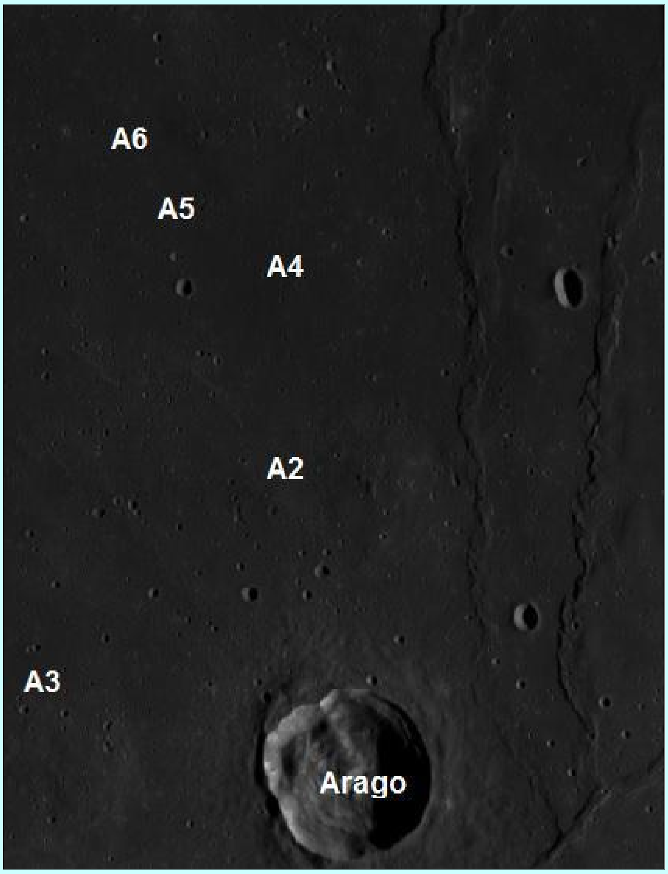
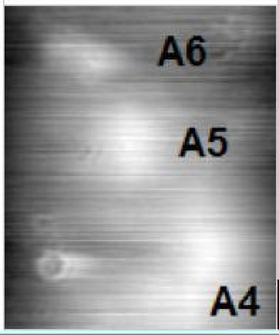


Figure 3: WAC imagery

The telescopic image shown in Fig. 2 was also used to derive an elevation map of the examined domes, obtaining a three-dimensional (3D) reconstruction. A well-known image-based method for 3D surface reconstruction is shape from shading (SfS). This technique makes use of the fact that surface parts inclined towards the light source appear brighter than surface parts inclined away from it. The SfS approach aims to derive the orientation of the surface at each image location by using a model of the reflectance properties of the surface and knowledge about the illumination conditions, finally leading to an elevation value for each image pixel [2]. Thus I have derived the DEM and the 3 D reconstruction (Fig. 4).



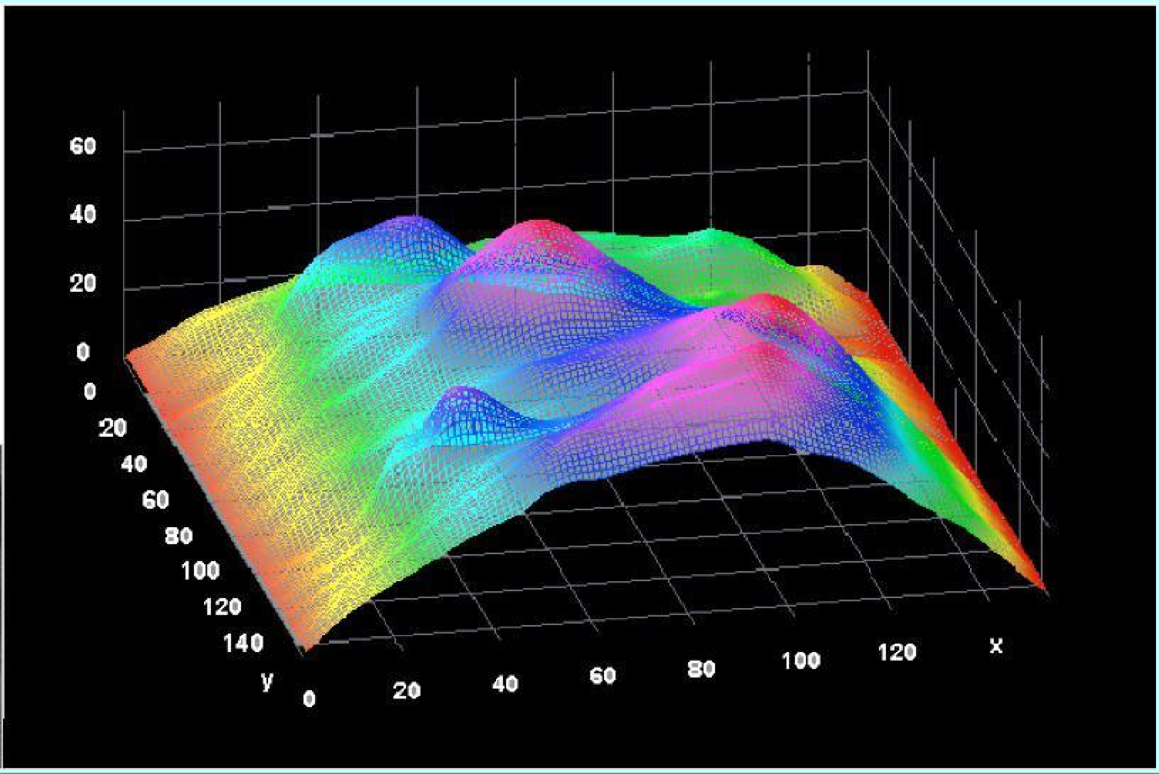


Figure 4: (left) DEM obtained using the telescopic image of Fig. 2. The domes A4-A6 are marked. (right) 3D reconstruction of A4-A6, vertical axis is 30 times exaggerated.

To the north of Arago lie two known lunar domes Arago α (termed A2) and Arago β (termed A3). These two large domes (Fig. 2)- A2 and A3- belong to class D and formed during several stages of effusion, representing non-monogetic domes. The other smaller domes in Arago show lower flank slopes and according to their rheologic properties, belong to class A implying low lava viscosities of about 10^3 Pa s, high effusion rates and very short durations of the effusion process of about 3–4 months.

In another previous work, published in this circular, a dome in Mare Spumans has been identified using LROC WAC imagery and named as Spumans 1 [5]. It lies at about 26 km south west of the crater Pomortsev.

An image of the dome was taken by Schenck on November, 21, 2021 at 03:16 UT using a C14 f/11 (Fig. 5).

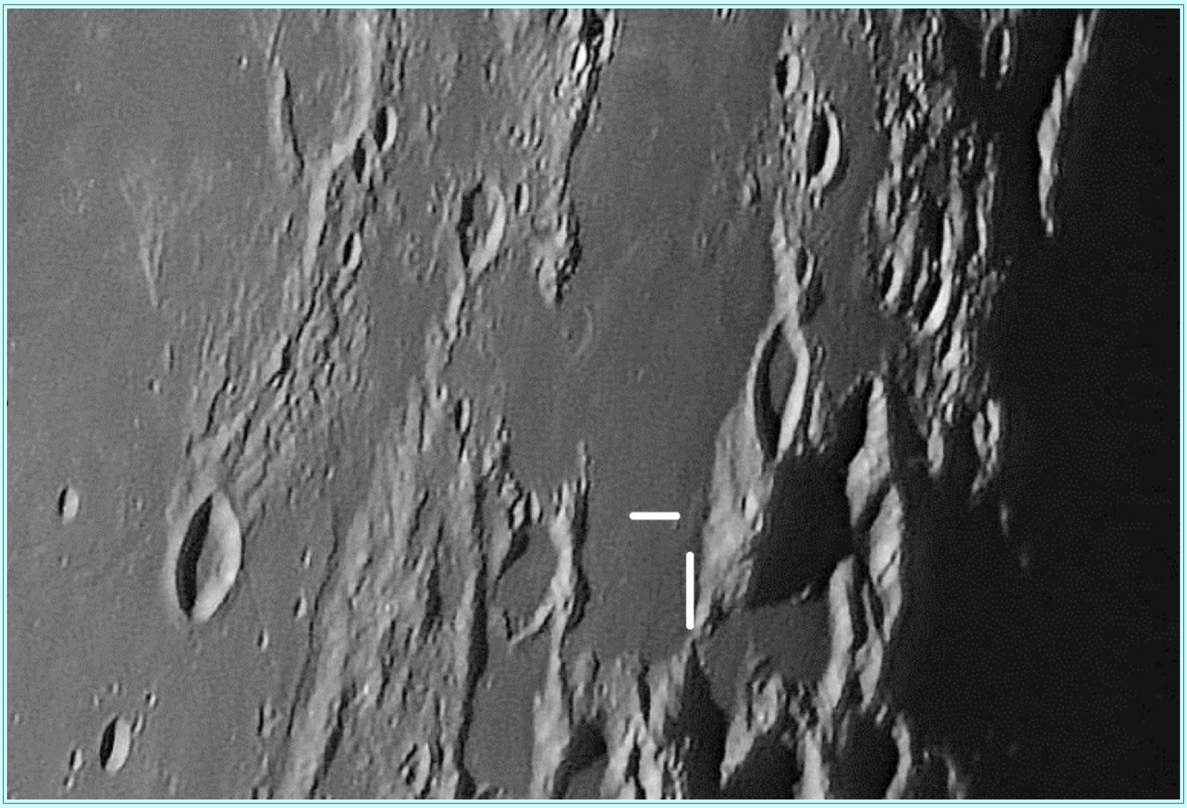


Figure 5: Telescopic image made by Schenck on November, 21 2021 03:16 UT. The dome Spumans 1 is marked with white lines.

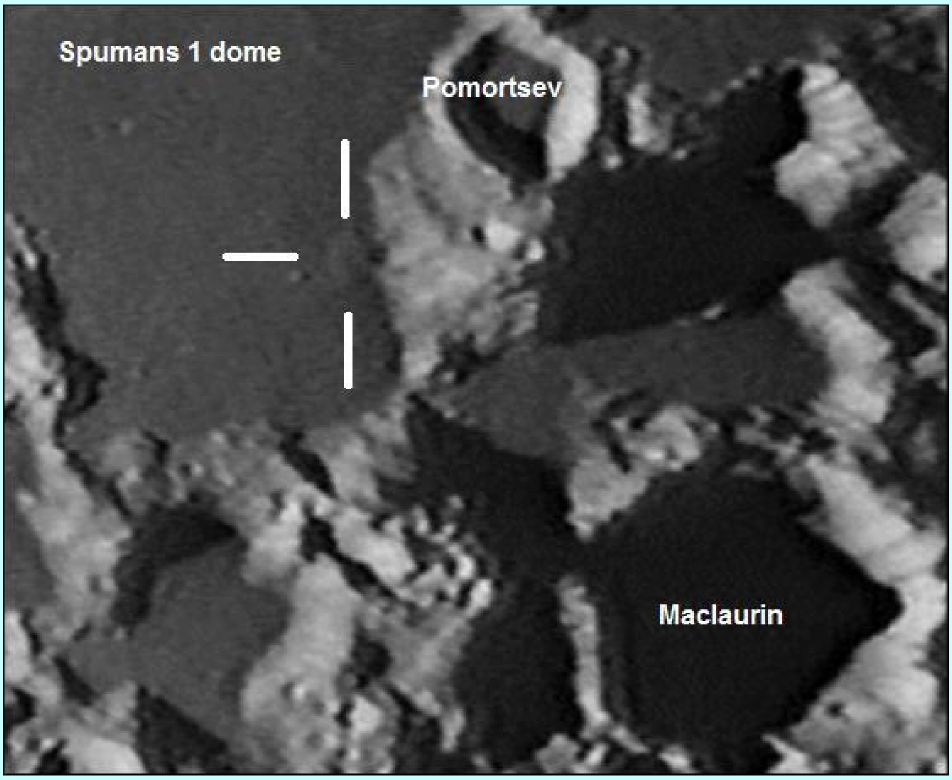


Figure 6: The dome Spumans 1 displays a circular shape. Image in cylindrical projection using LTVT software package.

I have deleted the foreshortening effect transforming the telescopic image in cylindrical projection**,** using LTVT software package by Mosher and Bondo (Fig. 6). Inversely, a synthetic image of a dome can also be generated based on an available DEM as seen from a given direction for lighting from some other specified direction. The LTVT software was used to generate synthetic view of selected parts of the LOLA DEM as cylindrical projection deleting, also in this case, the effect of foreshortening (Fig. 7).

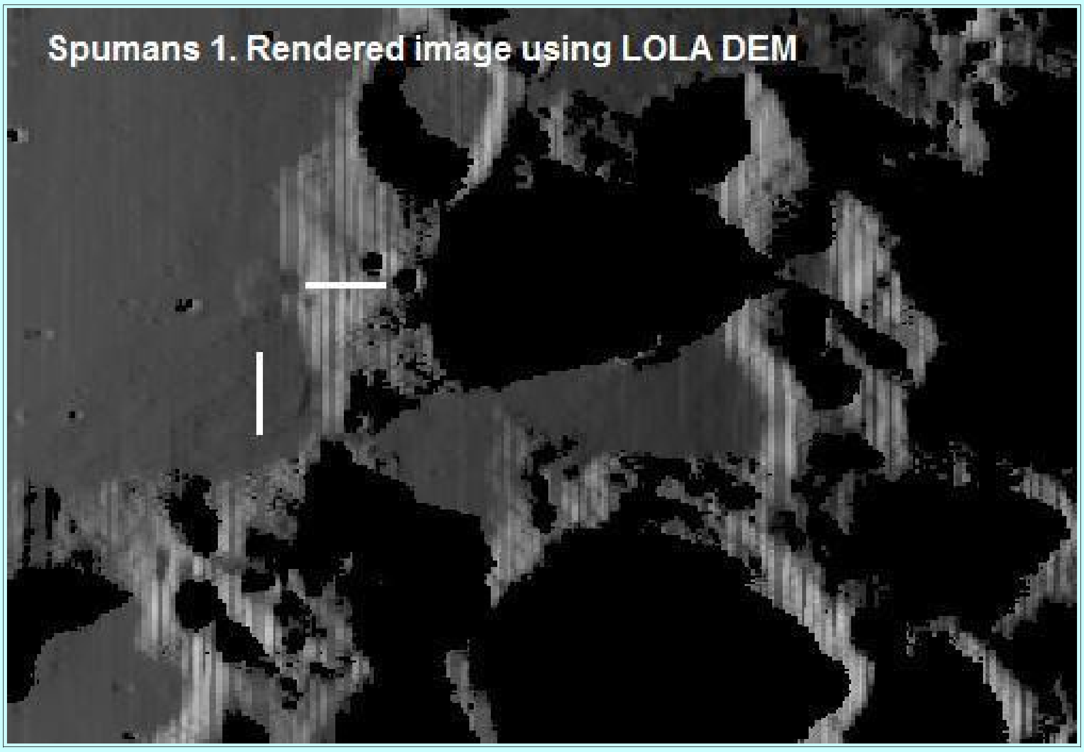


Figure 7: Image simulated based on the LOLA DEM using LTVT, displaying the dome Spumans 1 under the solar altitude of 3.9° as cylindrical projection, thus deleting the effect of foreshortening. The rendered image may be compared with the telescopic image shown in Fig. 6.

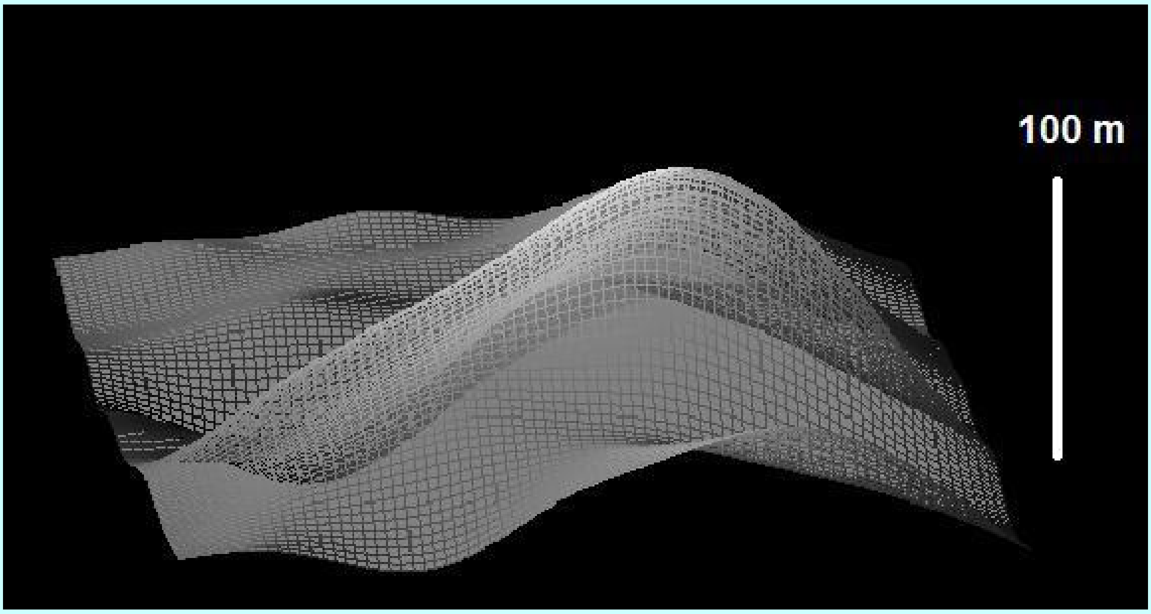


Figure 8: 3D reconstruction of Spumans 1, based on the telescopic image of Fig. 6. Vertical axis is 30 times exaggerated.

Based on the telescopic image, the dome has a base diameter of 8.5 ± 0.5 km. The height, determined using the photoclinometry and SfS approach [2], amounts to 95 ± 10m. A 3D reconstruction is shown in Fig. 8.

The search for lunar domes in the easternmost regions of the Moon can be a goal for amateur astrophotographers and astronomers. I encourage high-resolution imagery of this area using telescopic images, so that we can have more data about the dome Spumans 1, actually under study.

Please check also your past imagery of the Mare Spumans and send them to me for the ongoing study (raffaello.lena59@gmail.com).

References:

[1] Wilhems, D. The geologic history of the Moon, USGS Prof. Paper 1348, 1987.
[2] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. Lunar domes: Properties and Formation Processes, Springer Praxis Books.
[3] Rajmon, D., Spudis, P., 2001. Distribution and stratigraphy of basaltic units in Mare Tranquillitatis, Proc. Lun. Plan. Sci. Conf. XXXII, paper 2156.
[4] Lena, R. 2017. Lunar Domes (part VIII): Domes in the Arago region, BAA LS circular vol. 54, 1, January 2017, pp. 9-16.
[5] Lena, R. 2021. Lunar Domes (part LI): Searching domes in Mare Spumans, BAA LS circular vol. 58, 10, October 2021, pp. 23-26.
[6] Mosher, J., & Bondo, H., 2006. *Lunar Terminator Visualization Tool (LTVT)*. See: https://github.com/fermigas/ltvt/wiki

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LUNAR OCCULTATIONS. January 2022

by Tim Haymes

Time capsule:50 years ago in the January issue: with thanks to Stuart Morris for the LSC archives. https://britastro.org/downloads/10167

- P Moore: W.M "Bill" Baxter dies. (Solar observer and photographer of repute).
- Dundee AS members report a reddish patch in Theophilus. Several observers see it the blink: B.Tayor, M Findlay, K Kennedy.
- G.Falworth: Apollo 16 site is selected by NASA, a region north of Descartes, in lat 9 E, Long 16 S.

Review of O-C values

The Observed-Calculated (O-C) result for an observation is a quality indicator returned to the observer after reporting the timings. In the 1970/80/90s it was treated as a correction to the limb profile, but also contained systematic errors introduced by visual observers with a stop-watch. Their reaction times introduced uncertainty of several hundred milliseconds.

The use of O-C is important now that video timings to +/10ms are routinely submitted to IOTA. Its now possible to reanalyse old observations and obtain an O-C that is mostly due to timing errors rather than the shape of the Moon, at least from a simplistic approach. D Hall sent in these results 50 years ago:

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The method of re-analysis with Occult was to open Occul4 Lunar Observations and select View/analyse historic Occultations. A window opens where the observer name can be typed " D Hall". Observations made from Leicester, England are listed. Select one of the observations and the O-C is provided.

D Hall			O-C ("arc)	
Date	ZC	orig	listed	re-reduced*
1970 Dec 6,	3508,	-0.49	-0.05	+0.169.
1970 Dec 20,	1635,	-0.36	0.11	-0.319
1971 Jan 02,	3467,	+0.07	-0.18	+0.026.
1971 Feb 03,	0538,	-0.81	0.08	+0.280.
	0555,	+0.15	-0.04	+0.160.
	0571,	-0.12	+0.08	+0.297.
1971 Feb 14,	1759,	+0.06	+0.00	-0.274.
1971 May 02,	1396,	+0.01	-0.17	+0.045.
1971 May 03,	1486,	-0.13	+0.05	+0.205.
1971 May 04,	1497,	+0.09	-0.27	-0.126.
1971 Aug 08,	3380,	+0.23	-0.02	-0.316

*From the search list=> [create report] =>[Reduce & Plot]

I have been in contact with Dave Herald (Author of Occult4 software), and enquired how I should interpret these figures. More next month

Occultation Highlights this month.

6th 1645 tau Aquarii occulted at 1600 (in twilight).

26th 0347 5 Libra, Reappearance at the Dark limb (RD) Suspect double.

26th 0527 8 Libra (near Alpha) RD

26th 0535 alpha Libra RD

Best of luck with New Year Observations!

Occultation predictions for North Oxfordshire, 2022 January

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

Some fainter predictions may be omitted near Full Moon. Mag Limit 7.0

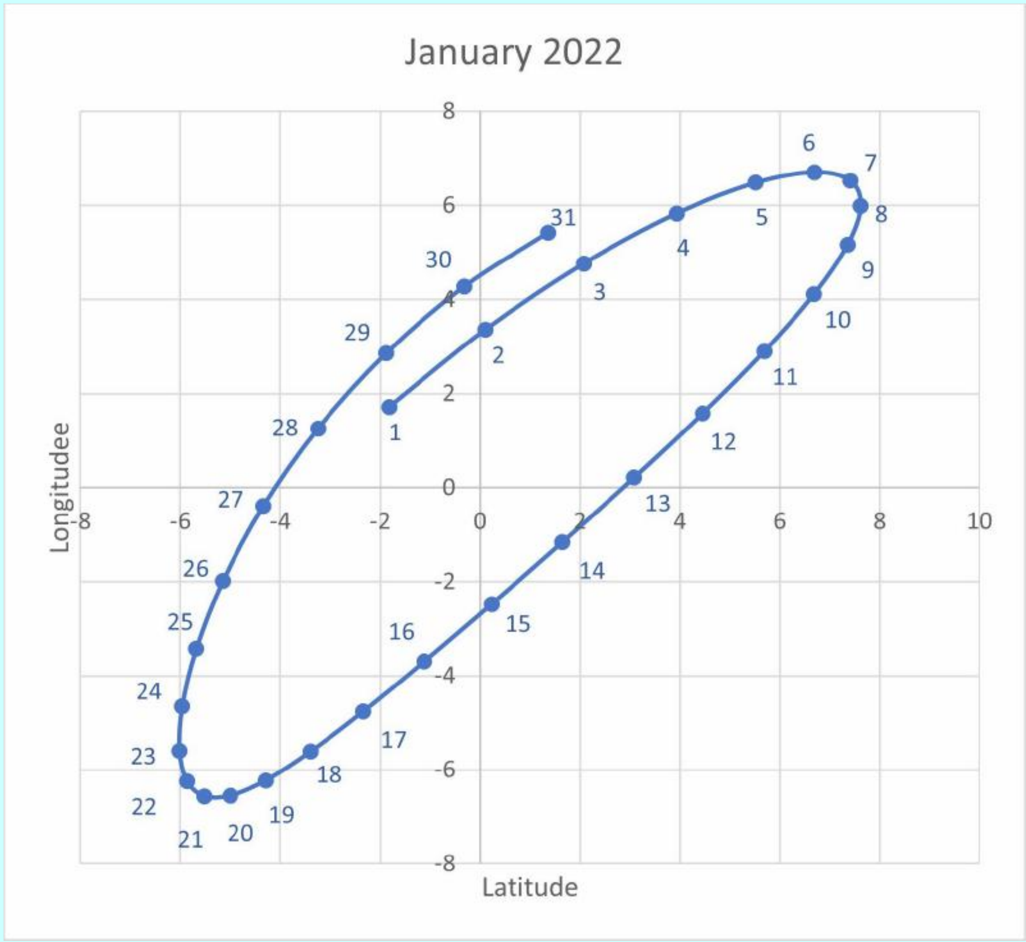
y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA	Notes
22	Jan	6	16	0	48.2	DD	3349	K5	4.1*	3.2	20+	53	0	25	183	24N	tau Aqr
3349 is double: AB 4.2 9.9 133" 297.4, dT = +184sec																	
22	Jan	6	16	45	36.2	RD	3349	K5	4.1*	3.2	20+	53	-5	24	195	-52N	tau Aqr
22	Jan	8	23	15	8.3	D	83	K2	6.6*	6.0	41+	80		2	267	28N	15 Ceti
22	Jan	9	13	58	29	m	170	K4	6.0*	5.2	48+	88	13	20	112	9S	33 Ceti
22	Jan	9	14	25	34	Gr	170	K4	6.0	5.2	48+	88	-1	17	124	8S	
22	Jan	9	22	29	30.1	D	202	G5	6.9*	6.3	51+	91		19	253	86N	
22	Jan	12	16	19	33.0	D	510	K2	6.8	6.0	77+	123	-1	34	105	62N	
22	Jan	12	17	27	42.1	R	510	K2	6.8	6.0	77+	123	-10	44	121	-88N	
22	Jan	13	16	1	7.4	DD	633	B9	5.5	5.5	84+	133	2	27	89	62S	53 Tau
633 is double: ** 6.2 6.2 0.050" 350.0, dT = -0.07sec																	
22	Jan	13	16	50	18.9	RD	633	B9	5.5	5.5	85+	134	-5	34	99	-36S	53 Tau
22	Jan	13	20	37	51	m	657	A7	5.3	5.1	85+	135		60	170	-12N	67 Tau
22	Jan	15	5	15	56.0	D	835	B8	7.0	6.9	93+	149		8	299	76S	
22	Jan	15	17	6	31.6	D	918	K0	7.0	6.5	95+	155	-6	25	80	74N	
22	Jan	16	16	27	34.6	D	1055	G0	5.7	5.4	98+	166	-1	12	65	39S	37 Gem
22	Jan	17	6	59	58.7	D	1117	G8	5.0	4.6	99+	171	-10	8	300	90N	57 Gem
1117 is double: ** 5.9 5.9 0.10" 90.0, dT = +0.17sec																	
22	Jan	20	20	23	16.6	R	1535	K0	6.9*	6.3	92-	146		9	79	67S	
22	Jan	20	21	6	26.1	DB	1544	M2	5.4*	4.5	91-	146		15	87	-75S	46 Leo
22	Jan	20	22	9	14.4	RD	1544	M2	5.4*	4.5	91-	146		25	99	85S	46 leo
22	Jan	21	22	21	22	R	1647	A2	6.7	6.5	85-	134		16	96	5N	
22	Jan	22	3	22	34.8	D	1669	F5	6.7*	6.5	83-	132		46	177	-42S	
22	Jan	22	4	26	9.7	R	1669	F5	6.7*	6.5	83-	131		44	200	72S	
22	Jan	23	1	47	19	M	1758	G5	6.9	6.4	75-	120		32	136	12S	
22	Jan	24	0	10	7.8	R	1864	K2	6.7*	5.9	66-	109		10	107	88N	
22	Jan	24	1	19	50.1	R	1869	K2	6.2*		66-	108		19	122	55S	46 Vir
1869 is triple: AB 6.18 8.78 0.57" 182.0, dT = -0.46sec																	
22	Jan	24	3	22	6.9	R	1875	F0	6.7*		65-	107		31	152	74N	48 Vir
22	Jan	25	4	30	24.8	R	1997	F5	6.9*	6.6	54-	94		26	160	24N	
22	Jan	26	3	47	47.6	R	2105	K2	6.3	5.7	43-	82		14	140	64S	5 Lib
22	Jan	26	5	27	7.9	D	2117	F3	5.2	4.9	42-	81		21	162	-66S	8 Lib
2117 is multiple: ** 6.1 6.1 0.10" 90.0, dT = +0.17sec																	
22	Jan	26	5	35	49.3	D	2118	A3	2.8	2.7	42-	81		21	165	-63S	alpha Lib
2118 is multiple: AD 2.7 7.3 266.0, dT = 0.00sec																	
22	Jan	26	6	38	1.8	R	2117	F3	5.2	4.9	42-	81	-11	22	181	88N	8 Lib
22	Jan	26	6	46	0.0	R	2118	A3	2.8	2.7	42-	81	-10	22	183	89S	alpha Lib
22	Jan	28	7	31	27.0	R	2417	A2	6.7	6.7	20-	54	-3	13	167	67N	18 Oph
22	Feb	5	17	24	40.8	DD	128	G5	7.0*	6.4	23+	57	-4	37	207	82N	
22	Feb	5	18	37	18.9	RB	128	G5	7.0*	6.4	23+	58		30	227	-70S	

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



Libration chart January 202

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SCHILLER
by Barry Fitz-Gerald.

The elongate Schiller is probably one of the most distinctive craters on the lunar surface, measuring some 179kms along its NW-SE axis and a maximum of some 64kms along a SW-NE axis. How it formed has been a subject of some debate as it obviously it is not the result of a vertical or near vertical impact. The two main hypotheses that are suggested to account for the unusual shape are that is is the result of a grazing impact of an asteroid or is the result of the impact of a fragmented body, with several individual craters coalesced into one elongate one.

The ejecta blankets of craters are often the best places to look for evidence of the impact angle, with features such as a "Zone of Avoidance" in the up-range direction, a "butterfly wing" ejecta pattern or a saddle shaped rim with the low points along the direction of the impactors trajectory. The distribution of impact melt can also provide a clue as it can be preferentially ejected in the down-range direction in some impacts. Unfortunately in the case of Schiller, erosion and the emplacement of nearby mare like units has obscured a lot of the original ejecta pattern, and there is no significant geochemical signature to distinguish the ejecta from the surrounding terrain.

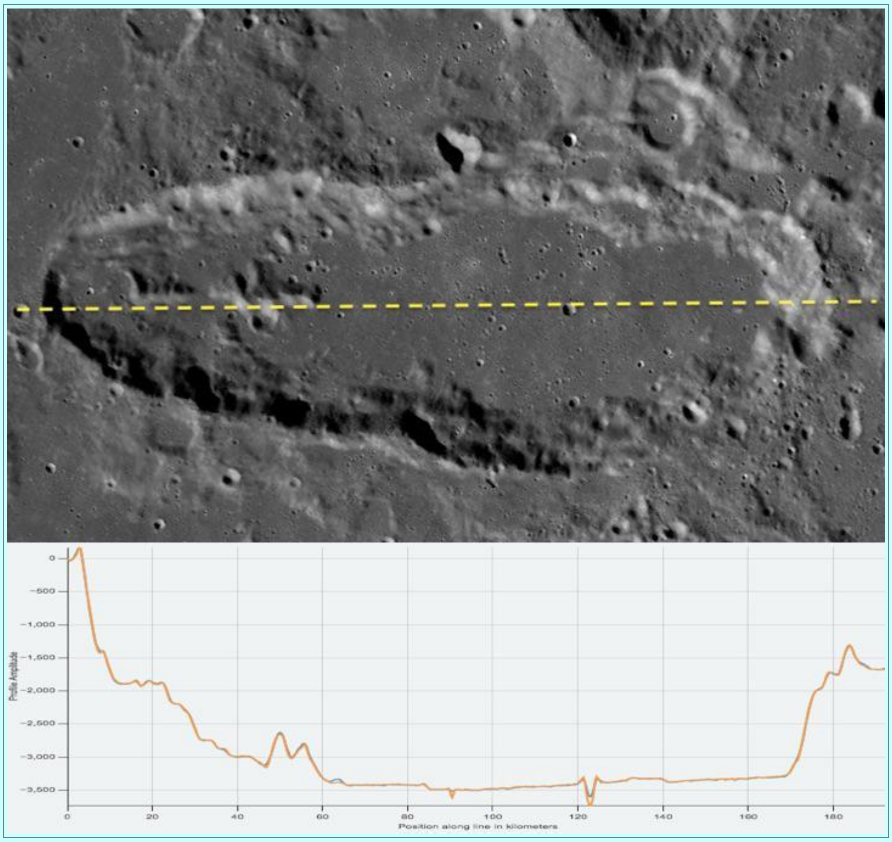

Fig.1 Topographic profile across long axis of Schiller showing the depressed floor and lower rim to the SE (right).

The topographic profile shown in Fig.1 reveals that the SE rim is significantly lower (~1500m) than the NW rim, and the crater floor is much lower towards the SE, although as can be seen it is deepest approximately mid way along its length. This would be consistent with a low angle impact from the SE, as the deepest part of the crater and the lowest point on the rim would be found here which would be the up-range direction.

The elongate central peak like structure on the western floor might also suggest a low angle impact, as similar peaks are found in other low angle impact craters such as Goclenius. If this is the case, the rest of the central peak or more accurately a central ridge must be submerged beneath the mare like units covering the floor of Schiller. Two isolated hills can be seen protruding above the smooth floor in line with the central peak/ridge which may represent the summits of a drowned ridge (Fig.2).

There are some features present in the preserved ejecta blanket that might indicate that a low angle impact might not be the whole story. Despite the ejecta appearing to be concentrated in a “butterfly pattern” either side of the crater long axis, Fig.2 shows six areas where the ejecta is arranged in an isosceles triangle type of pattern, with the base of the triangle located on the crater rim, and the long axis pointing approximately radially away. These may be individual “butterfly patterns” associated with individual craters within a crater chain type structure. If Schiller was caused by a number of individual but closely spaced impactors, say from a tidally disrupted body (à la Shoemaker–Levy 9) arriving on a low angle trajectory, then each of these might produce their own “butterfly patterns”, which could account for the rather sawtooth arrangement we see. Alternatively, these triangles of ejecta might represent another feature often seen in multiple impact craters.

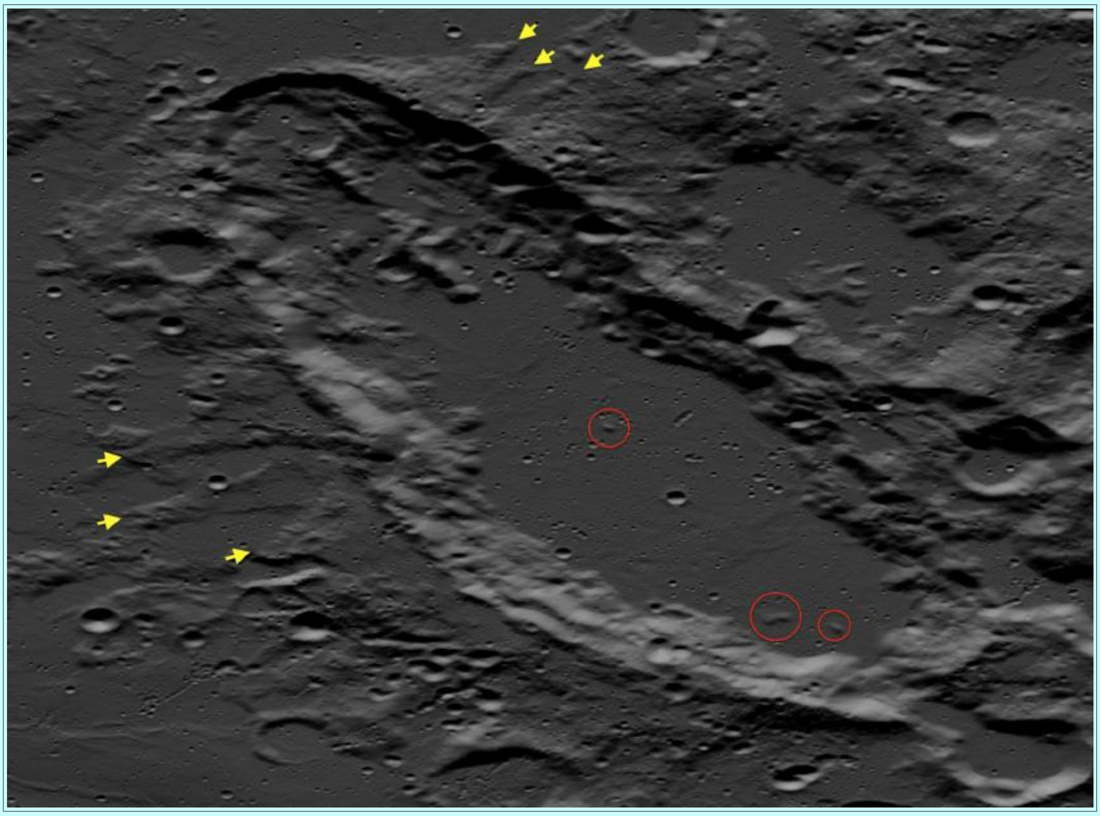

Fig.2 Schiller viewed in a rendered in a shaded relief model derived from elevation data (LRO Quickmap) showing a number of triangular features in the ejecta pattern (yellow arrows) and isolated hills (red circles) that may represent a submerged central ridge.

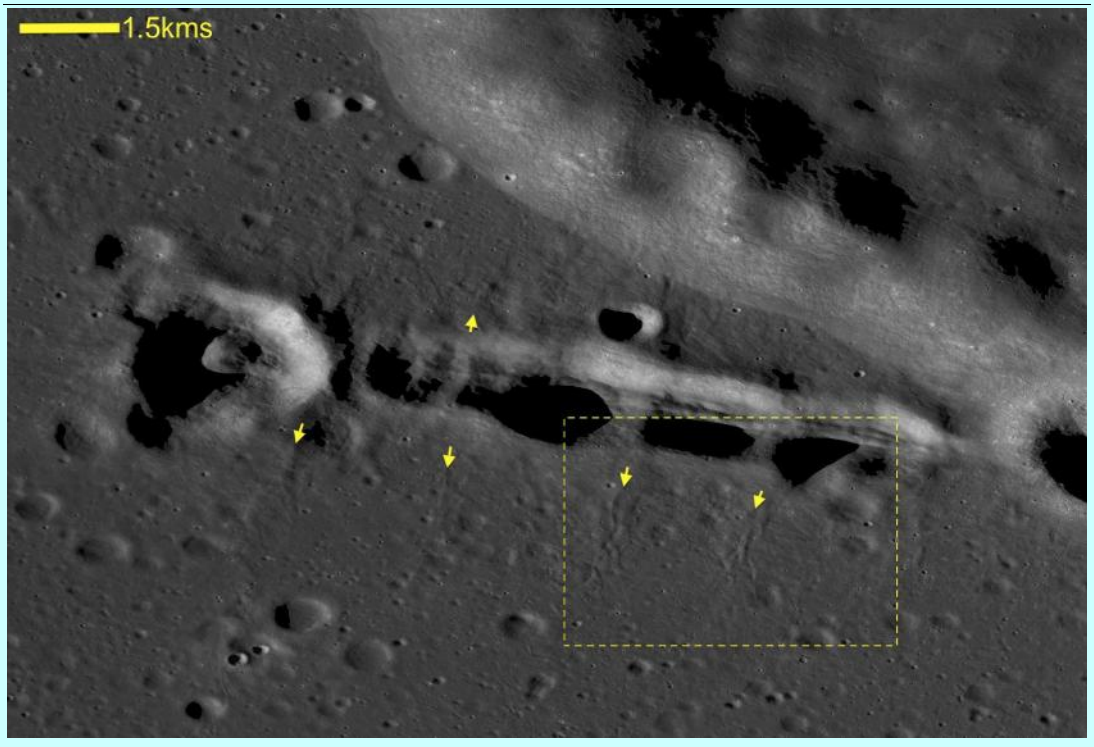

Fig.3 SELENE image of crater chain to the east of Repsold R. Interference ridges in the ejecta are indicated with yellow arrows. Note that their positions correspond to the septa between adjacent craters. Area within box shown in more detail in Fig.4.

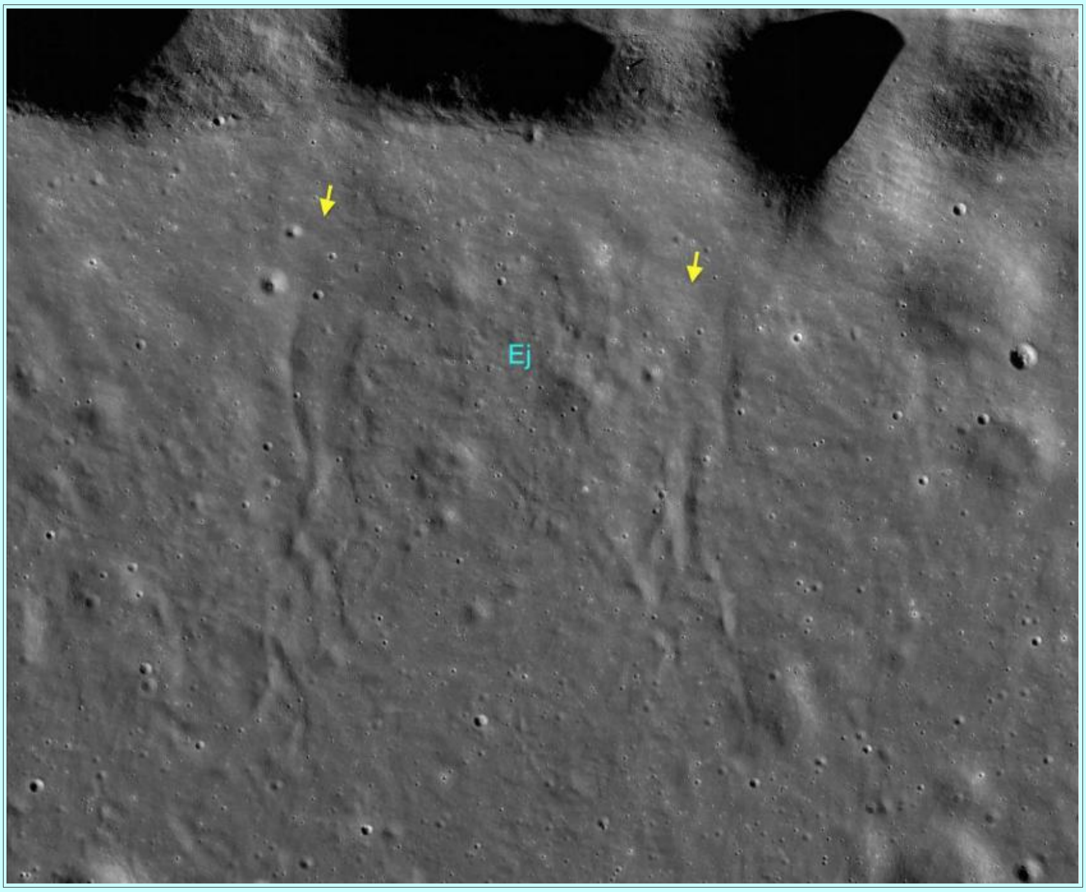

Fig.4 LROC-NAC image of the area within the yellow box in Fig.3. Interference ridges are identified with yellow arrows and "butterfly wing" ejecta is labeled Ej.

Fig.3 is a SELENE image of a crater chain just to the east of Repsold R. It probably represents the impact of a fragmentary body, where the individual components were arranged along the line of trajectory following a tidal disruption event. The low sun angle allows subtle features in the ejecta to be picked up, in particular the rather wavy, sub triangular features indicated with the yellow arrows. These represent deposits from where the ejecta cones of each individual crater interfered with its neighbour to produce a ridge like feature extending radially away from the septum between the craters. These ridge like features have been reproduced experimentally[1] and examples are visible in crater pairs such as Plato KA or crater chains such as Catena Davy. Of course the impactors may also be travelling on low angle trajectories relative to the lunar surface and be expected to produce their own "butterfly-wing" pattern as well. This can be seen in Fig.4 which is a detail from Fig.3, showing two of these interference ridges, with normal "butterfly-wing"ejecta deposits (Ej) located between them and belonging to the adjacent crater. Whether the triangular ejecta features seen in Schiller are interference ridges or individual "butterfly wings" is a moot point, their dimensions might suggest that they are more likely to be the latter, but whatever they are they do indicate that both the multiple *and* low angle impact hypotheses are valid for Schiller suggesting the impactor was a disrupted body (with fragments strung out along the line of travel) on a low angle trajectory from the SE.

Tidal disruption of asteroids has been implicated in the formation of lunar crater chains[2][3] such as Caten Davy and Catena Abulfeda but these are fairly modest in size compared to Schiller, and also rather better behaved with the individual craters fairly well aligned and spaced out. Schiller by contrast appears to have resulted from a disrupted body where the individual fragments were much more clustered as opposed to being spread out in a line. This might account for the fact that the ejecta either side of Schiller is not symmetrical as we see in Fig.3* with interference ridges and "butterfly wings" mirroring each other on either side of the crater. An slightly elongate rubble pile model for the impactor is also suggested by the presence of some rather subtle wrinkle ridge like structures on the mare like floor of Schiller. These may indicate the presence of submerged crater sub-units and their intervening rims. And of course the rather 'lumpy' crater outline as is evident in Fig.1 suggests Schiller may be composed of a number of almost overlapping individual craters. The tidal disruption of Near Earth Asteroids of the "rubble pile" type can produce a variety of fragmented bodies with the mass distributed in different ways amongst the resulting debris [ibid] but it might be unlikely that a near Earth interaction of this type would be sufficient to disrupt an impactor of the size required to explain Schiller – this might indicate that an *already* disrupted body entered the Earth-Moon system from elsewhere in the Solar System to create Schiller some time during the Nectarian Period.

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(barryfitzgerald@hotmail.com)

Acknowedgements:
LROC images reproduced by courtesy of the LROC Website at http://lroc.sese.asu.edu/index.html,
School of Earth and Space Exploration, University of Arizona.
Selene images courtesy of Japan Aerospace Exploration Agency (JAXA) at:
http://l2db.selene.darts.isas.jaxa.jp

References:
1. Oberbeck, V.R. (1973) Simultaneous Impact and Lunar Craters. The moon, Volume 6, Issue 1-2, pp. 83-92
2. Bottke, W.F., *et.al.* (1997) Can Tidal Disruption of Asteroids Make Crater Chains on the Earth and Moon? ICARUS 126, 470–474
3.Richardson, D.C.,*et.al.* (1998) Tidal Distortion and Disruption of Earth-Crossing Asteroids. ICARUS 134, 47–76
4. Fitz-Gerald, B. (2012) Zoomorphic Craters. Selenology Today, Issue 30.

* The morphology of the individual sub-craters in this chain actually suggest it was formed by the impact of a line of impactors, but that each individual impactor was itself a cluster of smaller fragments[4].

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LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

Note: it has not been possible, time wise, to produce a full report and analysis for Nov observations yet. Do not worry, as this will be concatenated onto the LGC article in February. A list of observers who contributed though is given below, However, if you are keen to see a preview take a look at the ALPO TLO when it is published at the start of Jan on: www.alpo-astronomy.org/gallery3/index.php/Lunar/The-Lunar-Observer/2022

BAA Reports received for included: Jay Albert (Lake Worth, FL, USA) observed: Archimedes, Aristarchus, Grimaldi, Langrenus, Mons La Hire, the lunar north polar region, Plato, Torricelli B and imaged several other features. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Arago, earthshine, Theophilus, and the whole lunar disks. 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. 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: the lunar eclipse, Ptolemeaus, and the region of Rupes Recti to the Valles Alpes. 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.

TLP reports: No TLP reports have been received, since the last newsletter.

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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