The Lunar Observer

A publication of the Lunar Section of ALPO

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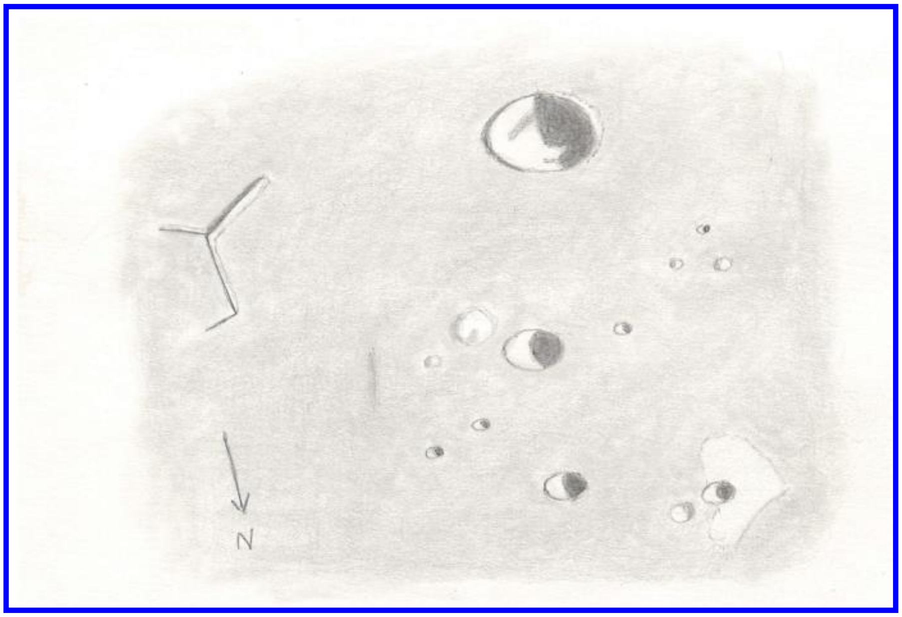
Recent back issues: http://moon.scopesandscapes.com/tlo_back.html

December 2019

Feature of the Month-Galle



Galle, drawn by Robert Hayes Jr., Worth, Illinois, USA.
18 September 2019 0912-0946 UT. 15 cm reflector, 170 x,
seeing 8-9/10, transparency 6.

I observed this crater and vicinity on the morning of 18 September 2019. This area is located in eastern Mare Frigoris north of Aristoteles. Galle itself is slightly triangular in shape and had an irregular internal shadow as depicted on the sketch. Galle C is north of Galle, and Kane G is farther north and slightly smaller. Kane F is west of and smaller than Kane G. These three lettered craters are all similarly crisp and deep, differing only in size. A large low mound is just southeast of Galle C and a small hill is nearby. Two small pits are northeast of Galle C and another pit is to its west. A shallow saucer is just northeast of Kane F and a bright patch is in the area. This patch is not well defined except for a fairly sharp curved northwest edge. Two small peaks are northwest of Galle and a tiny pit is nearby. This pit is smaller than the three near Galle C. The area east of Galle looks very smooth until an assemblage of linear features appears. A relatively wide ridge angles southwest from this junction, and a very narrow strip of shadow protrudes eastward from the group's north tip. These four segments are all very sharp and very straight. They do not appear to be part of a ghost ring nor are they ordinary wrinkles.

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In This Issue

I am hoping that each of you will have a very happy and safe Holiday Season! Perhaps Santa might leave a nice eyepiece or camera under your tree! Many thanks to all who contribute to making *The Lunar Observer* such a good resource for those of us who enjoy the moonlit nights. It has been a great pleasure for me to interact with you and get The Lunar Observer ready. I look forward to the year ahead.

In the issue ahead look for some interesting articles about lunar domes, both from the Raffaello Lena, Carmelo Zannelli, Maximilian Teodorescu and Jim Phillips article about lunar domes near the craters Hall and Luther along with several images and articles about domes from Howard Eskildsen. John Sabia takes us on a tour of the Moon with a 9.5 inch Alvin Clark refractor, though Damian Peach’s image of Plato through a 1 m telescope is also quite the view. Sounds like dream telescopes for such a purpose. As always, Tony Cook provides an engaging article about lunar geologic change. Tours of the lunar topography are presented in short articles, drawings, and images throughout this issue. Enjoy and have fun observing our nearest neighbour in space.

All the best and clear skies for 2020!

David Teske

David Teske
Acting Coordinator, Lunar Topographic Studies Program
Assn of Lunar & Planetary Observers

Lunar Calendar December 2019

2019	U.T.	EVENT
December 4	0658	First Quarter Moon.
5	0400	Moon at apogee, 404,446 km.
12	0512	Full Moon.
13	0400	Moon 1.5^{o} south of M35.
14		Greatest north declination, +23.2^{o}.
15	1600	Moon 1.0^{o} north of M44.
18	2000	Moon at perigee, 370,265 km.
19	0457	Last Quarter Moon.
26	0514	New Moon, lunation 1,200.
27	1500	Pluto 0.6^{o} north of the Moon, occultation in the Antarctica region.
27		Greatest south declination, -23.2^{o}.
29	0200	Venus 1.0^{o} north of the Moon, occultation in southern South America and Antarctica.

Lunar Librations December 2019

Libration in longitude: East limb most exposed on the 26th, +5.0^{o}, west limb mo.st exposed on the 2th, -4.7^{o}.

Libration in latitude: North limb most exposed on the 7th, +6.8^{o}, south limb most exposed on the 20th, -6.8^{o}.

The Lunar Observer welcomes all lunar related images, drawings, articles, reviews of equipment and reviews of books. You do not have to be a member of ALPO to submit material, though membership is highly encouraged. Please see below for membership and near the end of *The Lunar Observer* for submission guidelines.

Comments and suggestions? Please send to David Teske, contact information page 1. Need a hard copy, please contact David Teske.

AN INVITATION TO JOIN THE A.L.P.O.

The Lunar Observer is a publication of the Association of Lunar and Planetary Observers that is available for access and participation by non- members free of charge, but there is more to the A.L.P.O. than a monthly lunar newsletter. If you are a nonmember you are invited to join our organization for its many other advantages.

We have sections devoted to the observation of all types of bodies found in our solar system. Section coordinators collect and study members' observations, correspond with observers, encourage beginners, and contribute reports to our Journal at appropriate intervals.

Our quarterly journal, *The Journal of the Association of Lunar and Planetary Observers-The Strolling Astronomer*, contains the results of the many observing programs which we sponsor including the drawings and images produced by individual amateurs. Additional information about the A.L.P.O. and its Journal is on-line at: **http://www.alpo-astronomy.org.** I invite you to spend a few minutes browsing the Section Pages to learn more about the fine work being done by your fellow amateur astronomers.

To learn more about membership in the A.L.P.O. go to: **http://www.alpo- astronomy.org/main/member.html** which now also provides links so that you can enroll and pay your membership dues online.

LUNAR TOPOGRAPHICAL STUDIES

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OBSERVATIONS RECEIVED

Alberto Anunziato, Oro Verde, Argentina. Article and drawing The High Terrain Around Dawes.

Jairo Chavez, Popayán, Columbia. Images of Werner, Mare Serenitatis, Aristillus, Waxing Gibbous Moon and Tycho.

Howard Eskildsen, Ocala, Florida, USA. Articles and images Mairan, Gruithuisen Domes and Mons Rumker, Capuanus Dome 1, Wallace and Huxley Domes, images of Mare Australe, Valentine Dome, Palus Putredinus Dome-1, Marius Domes, Herodotus Omega Dome, T. Mayer Domes, Hortensius, Milichius Domes, Lansberg D Domes and Promontorium Laplace Dome 5.

Desiré Godoy, Oro Verde, Argentina. Images of Alphonsus, Tycho, Theophilus, Proclus and Langrenus.

Robert Hayes Jr., Worth, Illinois, USA. Article and drawing of Galle.

Richard Hill, Tucson Arizona, USA. Articles and images A Bit of Thebit, Lengthening Shadows (Rupes Altai), Craggy Morning (Cassini to Caucasus) and Central Trio (Arzachel to Flammarion).

Luigi Morrone, Agerola, Italy. Images of Arzachel, Rupes Recta and Purbach, Alphonsus, Arzachel and Ptolemaeus, Copernicus, Aristarchus and Vallis Schroteri, Aristoteles and Eudoxus, Atlas and Hercules and Endymion.

Damian Peach. Image of Plato.

Jim Phillips. Article and images Lunar Domes Near the Craters Luther and Hall: a Preliminary Report.

Lena, Raffaello. Article and images Lunar Domes Near the Craters Luther and Hall: a Preliminary Report.

John D. Sabia, Keystone College, Thomas G. Cupillari Observatory, Fleetville, Pennsylvania, USA. The Moon Through a 9.5" Alvin Clark Refractor!

Sweetman, Michael E., Tucson, Arizona, USA. Image of Theophilus-Rupes Altai-Larrieu's Dam.

Maximilian Teodorescu. Article and images Lunar Domes Near the Craters Luther and Hall: a Preliminary Report.

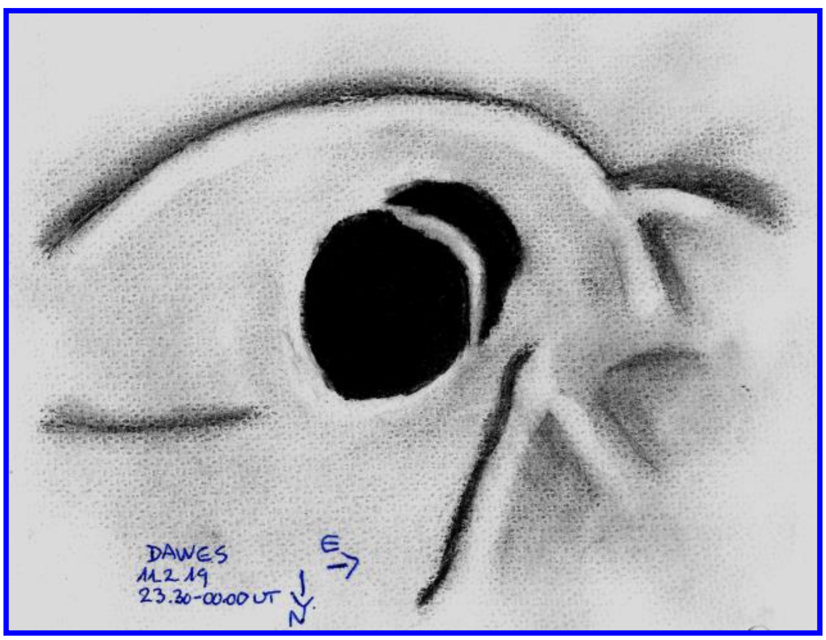
David Teske, Louisville, Mississippi, USA. Article and image of Pythagoras.

Carmelo Zannelli. Article and images Lunar Domes Near the Craters Luther and Hall: a Preliminary Report.

The High Terrain Around Dawes

Alberto Anunziato

Touring the vicinity of the terminator at colongitude 338.0º, the Copernican crater Dawes (18 km) caught my attention. Not because of its own characteristics, indistinguishable with the shadows completely covering its interior. Dawes seemed to be located in an elevated area, which could be deduced from the shadows that surrounded it, that seemed to indicate elevations (shadows and slightly bright lines, which usually indicate the light of the rising sun over the highest areas). Dawes is on an elevated area, which looks like a promontory pointing towards Plinius? It was difficult to find an answer. The images available on the Internet and the atlases did not mark any elevation. The first confirmation that my eyes had not deceived me was found in "The Lunar Crater Dawes" (JR Donaldson), available at https://www.asprs.org/wp-content/uploads/pers/1969journal/mar/1969_mar_239_-245.pdf It is a heterodox study, which supports the volcanic origin of Dawes in 1969, in which we read: "as indicated by LAC 42 the slope of the surrounding terrain is away from the rim of the crater Dawes which is 300 meters higher than the mare surface. This would tend to indicate the presence of a small anticlinal structure with the apex in the proximity of Dawes and the limbs sloping outward from the crater" (pages 241/242). Centuries ago one of the first lunar observers, the Polish Johannes Hevelius, pondered in his wonderful "Selenographia" (1647) about the importance of accurately recording with our drawing what our eyes see: "the astronomy cultivator knows that his eyes are as useful as his hands, which will express on paper what he observes". It was a great joy to find in Figure 5.17 (page 93) of "The Geological History of the Moon" by Don Wilhelms (United States Government Printing Office, Washington, 1987), the confirmation that Dawes is higher than the Mare Tranquillitatis surface (figure 2).



***Dawes**, Figure 1, Alberto Anunziato, Paraná, Argentina. 02 November 2019 2330 to 0000 UT. Meade ETX 105 telescope, 154 x.*

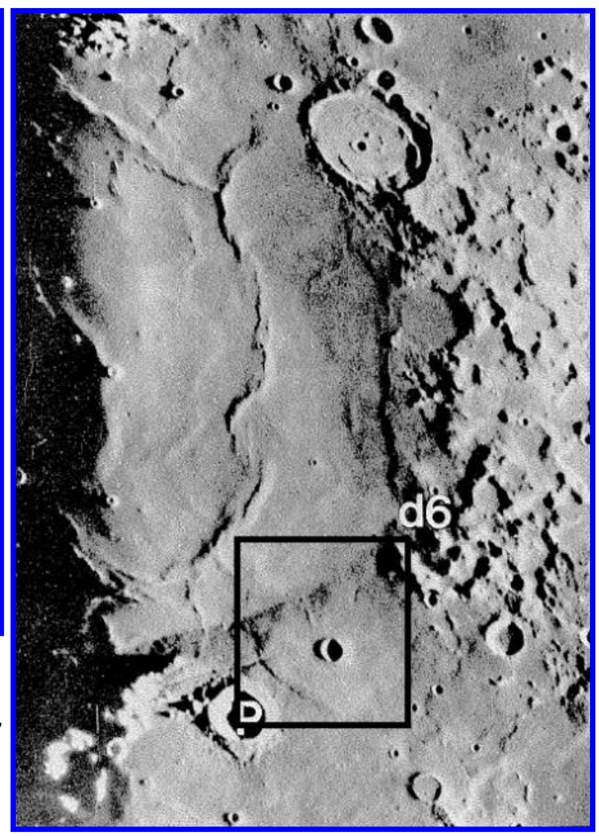


***Figure 2,** Area of Dawes.*

Lunar Domes Near the Craters Luther and Hall: a Preliminary Report

Raffaello Lena, Carmelo Zannelli, Maximilian Teodorescu and Jim Phillips

The current study describes two lunar domes, located near the craters Luther and Hall (which we termed Luth1 and Hall1). The morphometric characteristics of the domes have been examined by making use of a combined photoclinometry and shape from shading approach [1-2] and Lunar Reconnaissance Orbiter (LRO) WAC image, including LOLA DEM data set. In the LRO WAC imagery the examined domes are not as prominent as in the telescopic CCD images taken under lower solar illumination angle.

Ground-based observations

A telescopic CCD image of the examined lunar region, near the crater Luther located to northwest of Posidonius, is shown in **Fig. 1**. The image was taken on October 18, 2019 at 00:21 UT by Zannelli using a DK 20" telescope with aperture of 508 mm f/14. For image acquisition a GS3-U32356M-C camera was employed.

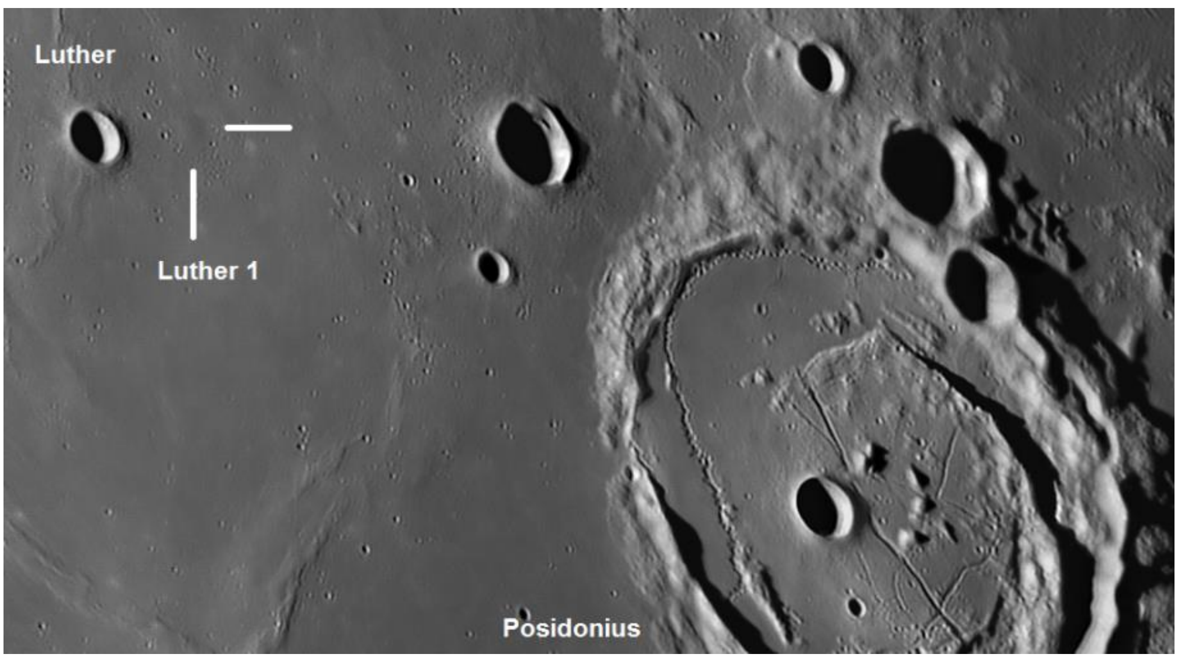


Figure 1: *Telescopic CCD image made on October 18, 2019 at 00:21 UT by Zannelli. Crop of the original image. The dome Luther 1 (Luth1) is marked with white lines.*

Another image of the dome Luther 1 was made by Teodorescu on October 10, 2017 at 04:02 UT using a 355 mm Newtonian telescope and ASI 174MM camera (**Fig. 2**).

Fig. 3 displays the second examined dome, termed Hall 1. The image was taken on October 18, 2019 at 00:21 UT by Zannelli.

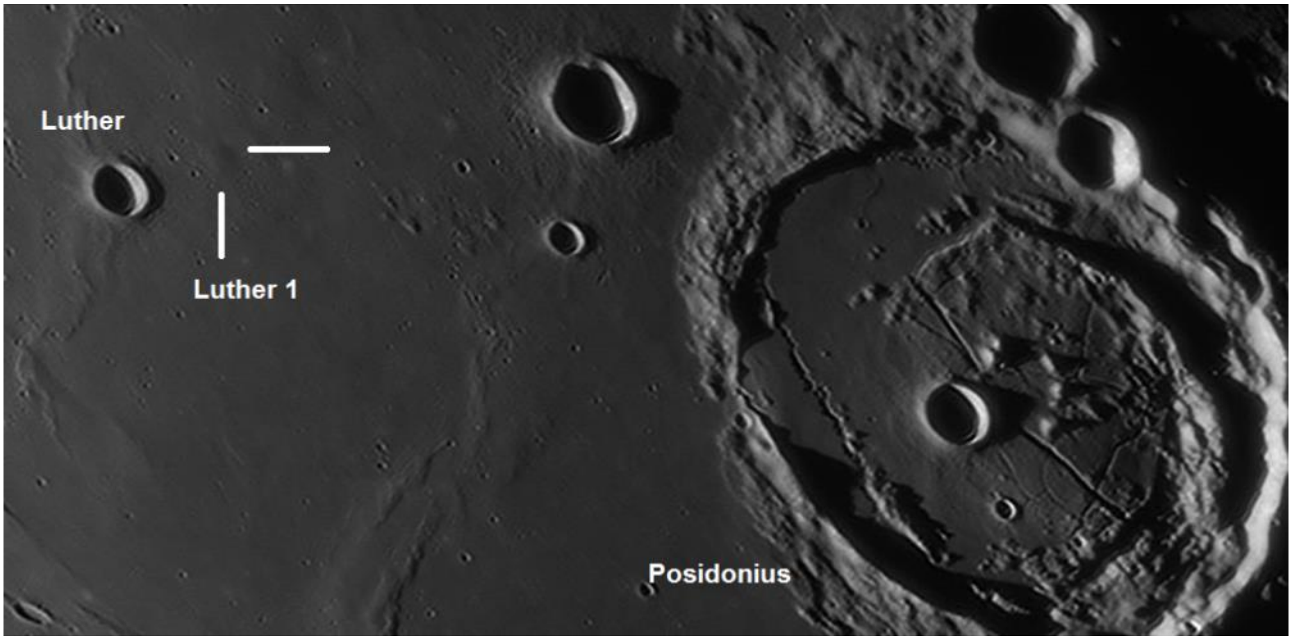


Figure 2: *Telescopic CCD image made on October 10, 2017 at 04:02 UT by Teodorescu. Crop of the original image. The dome Luther 1 (Luth1) is marked with white lines.*

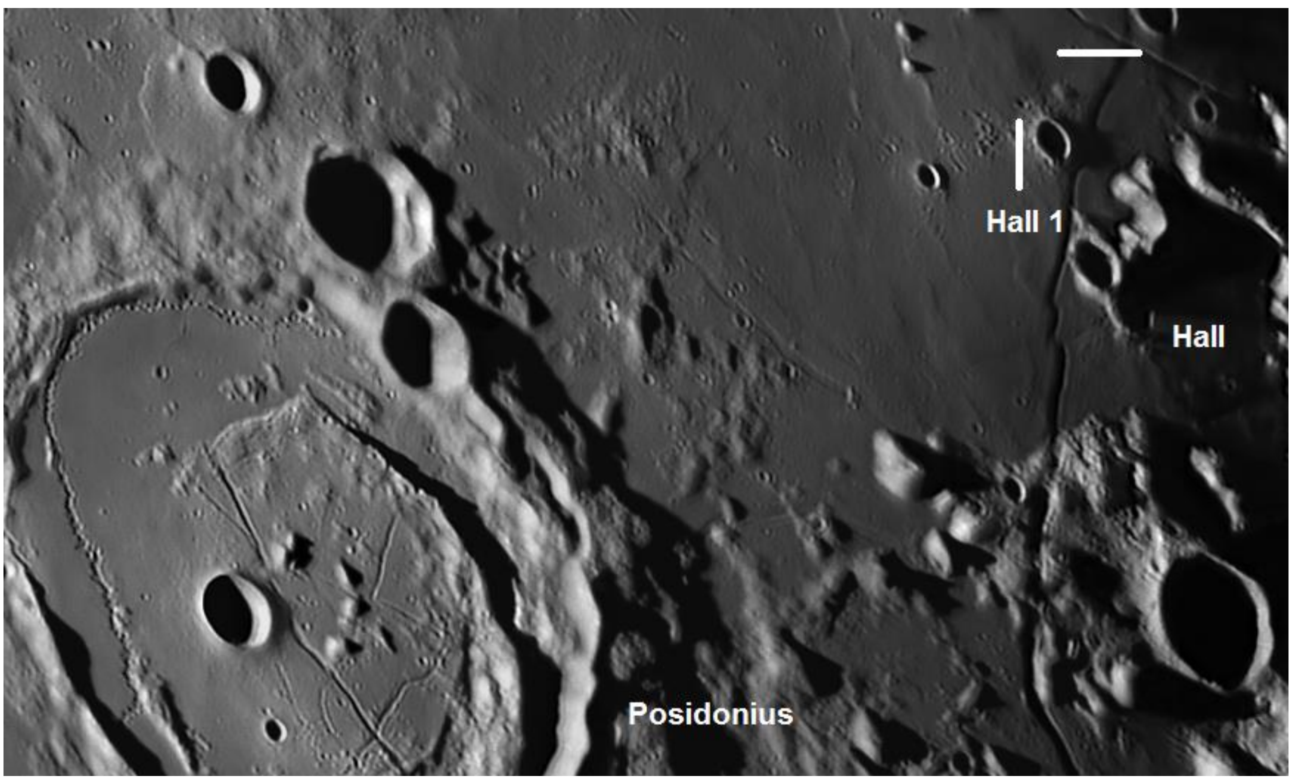


Figure 3: *Telescopic CCD image made on October 18, 2019 at 00:21 UT by Zannelli. Crop of the original image. The dome Hall 1, located to the north of the crater Hall, is marked with white lines.*

Digital elevation map based on telescopic CCD imagery

Generating an elevation map of a part of the lunar surface requires its three-dimensional (3D) reconstruction. A well-known image-based method for 3D surface reconstruction is shape from shading (SfS). It 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 for deriving 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 [3]. The

SfS method requires accurate knowledge of the scattering properties of the surface in terms of the bidirectional reflectance distribution function (BRDF). The iterative scheme used for photoclinometry and SfS approach is described in previous articles published in [4-6].

The height h of a dome was obtained by measuring the altitude difference in the reconstructed 3D profile between the dome summit and the surrounding surface, considering the curvature of the lunar surface. The average flank slope ζ was determined according to: $\zeta = \arctan 2h/D$. The uncertainty results in a relative standard error of the dome height h of ±10 percent, which is independent of the height value itself. The dome diameter D can be measured at an accuracy of ± 5 percent. The 3D reconstruction of the dome Luther 1 is reported in **Figs. 4-5**, while the 3D reconstruction of Hall 1 is shown in **Fig. 6**.

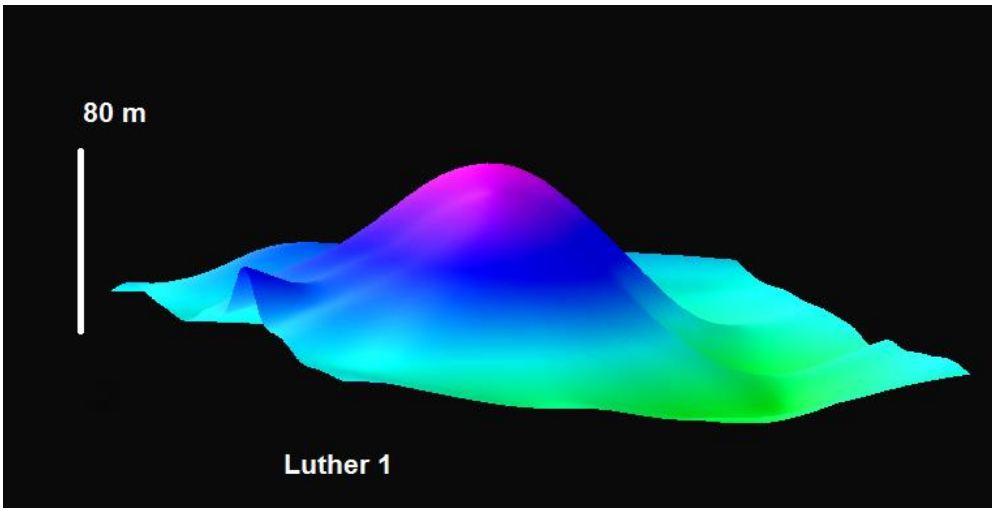


Figure 4: *3D reconstruction of Luther 1 based on terrestrial CCD image of Fig. 1 by photoclinometry and SfS analysis. The vertical axis is 20 times exaggerated.*

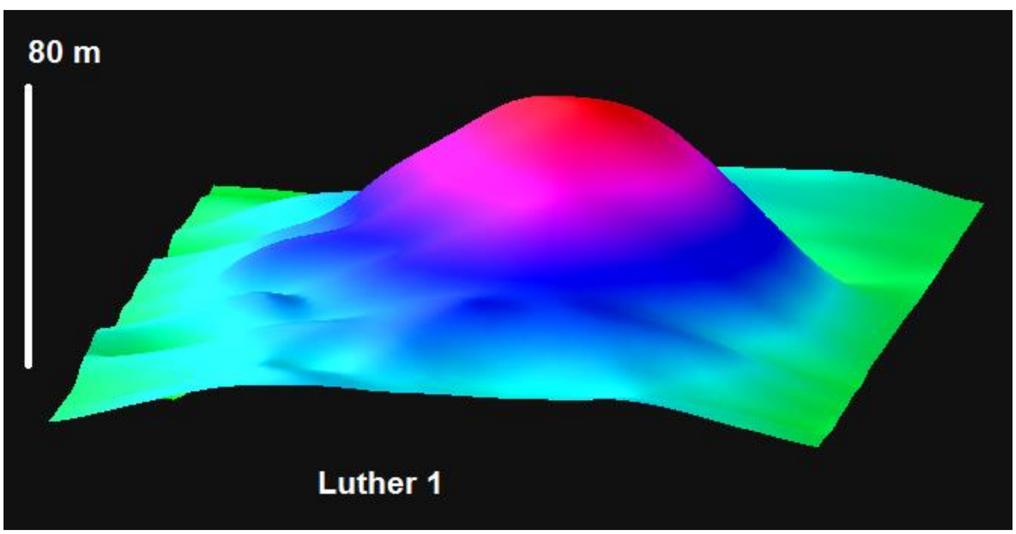


Figure 5: *3D reconstruction of Luther 1 based on terrestrial CCD image of Fig. 2 by photoclinometry and SfS analysis. The vertical axis is 20 times exaggerated.*

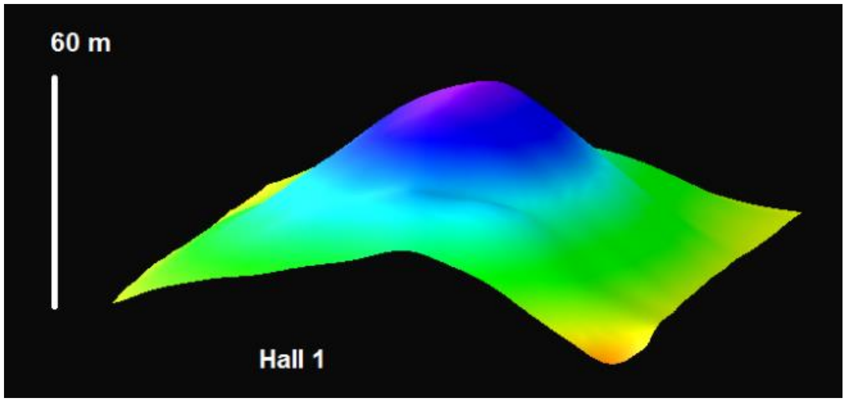


Figure 6: *3D reconstruction of Hall 1 based on terrestrial CCD image of Fig. 3 by photoclinometry and SfS analysis. The vertical axis is 20 times exaggerated.*

LOLA DEM

ACT-REACT Quick Map tool [7] was used to access to the LOLA DEM dataset, allowing to obtain the cross-sectional profiles for the examined domes (**Figs. 7-8**). Note the agreement of the measurements carried out on CCD telescopic images and the LOLA DEM.

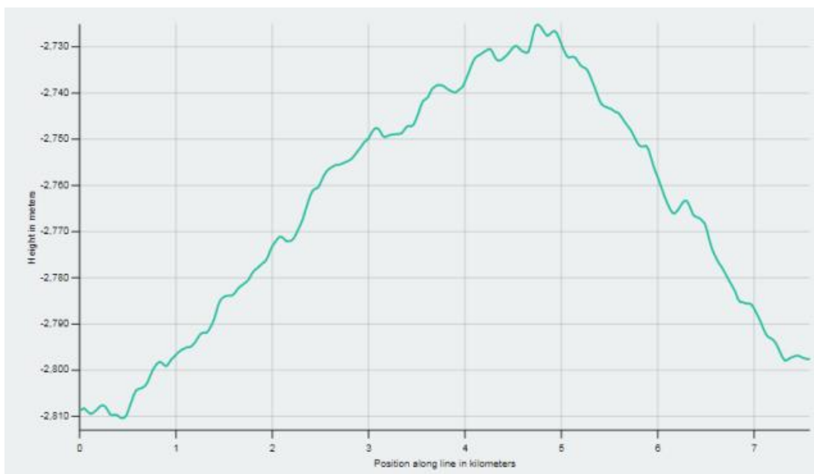


Figure 7: *LRO WAC-derived surface elevation plot of Luther 1 based on LOLA DEM.*

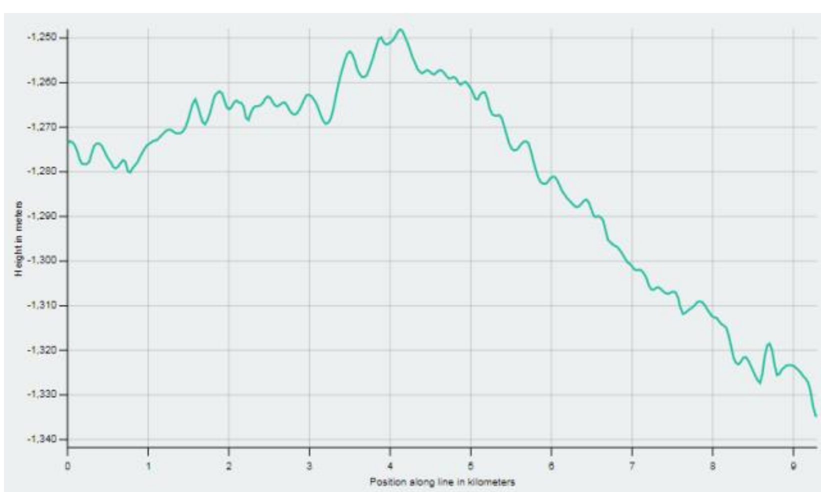


Figure 8: *LRO WAC-derived surface elevation plot of Hall 1 based on LOLA DEM.*

Results and discussion

Factors governing the morphological development of volcanic edifices are interrelated, including the viscosity of the erupted material, its temperature, its composition, the duration of the eruption process, the eruption rate, and the number of repeated eruptions from the vent. The viscosity of the magma depends on its temperature and composition. Thus, the steeper domes represent the result of cooler, more viscous lavas with high crystalline content. On the Earth, low and flat edifices are formed by basaltic lavas, such as the large Icelandic shield volcanoes, while more viscous lavas (such as andesitic and rhyolitic lavas with higher silica content) tend to build up steep volcanic edifices [8].

Because of the low silica and alumina content and high iron and titanium content the lunar basalt lavas had a higher temperature, lower viscosity, and higher density than terrestrial basalt lavas [8]. Temperature has a strong influence on viscosity: as temperature increases, viscosity decreases an effect particularly evident in the lava flows [9].

Dome Luther 1

The dome termed Luther 1 is located at 24.89º E and 33.39º N, with a diameter of 7.5 km ± 0.3 km. The height amounts to 80 ± 10 m, yielding an average flank slope of 1.2° ± 0.1°. The dome edifice volume is determined to 1.7 km³ assuming a parabolic shape. The rheologic model [1, 10] yields an effusion rate of 168 $m^3 s^{-1}$ and a lava viscosity of 9.5 x 10^4 Pa s. It formed over a period of time of 0.4 years. The Clementine UVVIS spectral data indicate a low to moderate TiO_2 content with a color ratio R_{415}/R_{750} = 0.6028. According to the classification scheme for lunar domes [1] Luther 1 is situated between class C_2 and C_1.

Dome Hall 1

The dome Hall 1, located north of crater Hall, lies at coordinates 35.69 º E and 35.12° N, with a base diameter of 8.0 km ± 0.3 km. The height amounts to 60 m ± 10 m yielding an average flank slope of 0.90° ± 0.1°. The edifice volume is determined to 1.5 km^3. The rheologic model [1, 10] yields an effusion rate of 260 $m^3 s^{-1}$ and lava viscosity of 2.0 x 10^4 Pa s. It formed over a period of time of 0.2 years. The Clementine UVVIS spectral data reveal a color ratio of R_{415}/R_{750} = 0.5591, indicating a low TiO_2 content. According to the classification scheme for lunar domes [1] Hall 1 belongs to class C_2.

Diviner Lunar Radiometer Experiment and Christiansen Feature (CF)

The Lunar Reconnaissance Orbiter's (LRO) Diviner Lunar Radiometer Experiment (spatial resolution of 950 m/pixel) produces thermal emissivity data, and provide compositional information from three wavelengths centered around 8 μm that are used to characterize the Christiansen Feature (CF), which is directly sensitive to silicate mineralogy and the bulk SiO_2 content. These spectral bandpass filters are centered at 7.00, 8.25, and 8.55 μm. The major minerals of lunar soils- plagioclase, pyroxene, and olivine- have different ranges of CF values [11]. The feldspar and high silicic material, including quartz, silica-rich glass, and alkali and ternary feldspars, are characterized by CF values of 7.8-7.3. In case of olivine abundances, the CF values is >8.7 [11]. We used the ACT-React Quick Map to infer the CF map derived from Diviner. Analyses of the Diviner CF map for the examined domes reveals that they do not display the short wavelength CF position characterizes silica-rich lithologies like the Gruithuisen domes. The average CF position of Luther 1 and Hal 1 domes is 8.30 ± 0.1; this value is not significantly different from the average CF position of the typical basaltic maria, which is 8.30-8.40. Hence, the examined domes are not enriched in silica relative to the surrounding mare units and display a basaltic composition.

Conclusion

Two low lunar domes, termed Luther 1 and Hall 1, have been characterized in their morphometric properties. A full spectral analysis based on M^3 dataset is in progress. We encourage more high-resolution imagery of this wide lunar region so that we can have more data to identify further lunar domes not characterized in the morphometric and spectral properties yet. Please check also your past imagery and send them to us for the ongoing study (lunar-domes@alpo-astronomy.org).

References

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

[2] Wöhler, C., Lena, R., Lazzarotti, P., Phillips, J., Wirths, M., & Pujic, Z., 2006. A combined spectrophotometric and morphometric study of the lunar mare dome fields near Cauchy, Arago, Hortensius, and Milichius. Icarus, 183, 237–264.

[3] Horn, B. K. P., 1989. Height and Gradient from Shading. MIT technical report 1105A. http://people.csail.mit.edu/people/bkph/AIM/AIM-1105A-TEX.pdf

[4] Lena, R., Pau, KC, Phillips, J., Fattinnanzi, C., Wöhler, C., 2006. Lunar domes: a generic classification of the dome near Valentine, located at 10.26° E and 31.89° N, JBAA, vol 116, 1, pp. 34-39.

[5] Viegas, R., Lena, R., Wöhler, C., Phillips, J. 2006. A study about the T. Mayer B highland dome, JBAA, vol. 116, 5, pp. 266-270.

[6] Lena, R., Wöhler, C., Bregante, M. T., Fattinnanzi, C., 2006. A combined morphometric and spectrophotometric study of the complex lunar volcanic region in the south of Petavius. Journal of the Royal Astronomical Society of Canada 100 (1), pp. 14-25.

[7] ACT react quick map. http://target.lroc.asu.edu/q3/

[8] Whitford-Stark, J.L., Head, J.W., 1977. The Procellarum volcanic complexes: Contrasting styles of volcanism. Lunar Planet. Sci. VIII, 2705–2724.

[9] Spera, F.J., 2000. Physical properties of magma. In: Sigurdsson, H. (Ed.), Encyclopedia of Volcanoes. Academic Press, San Diego.

[10] Wilson, L., & Head, J. W., 2003. Lunar Gruithuisen and Mairan domes: Rheology and mode of emplacement. Journal of Geophysical Research, 108 (E2), 5012, doi:10.1029/2002JE001909.

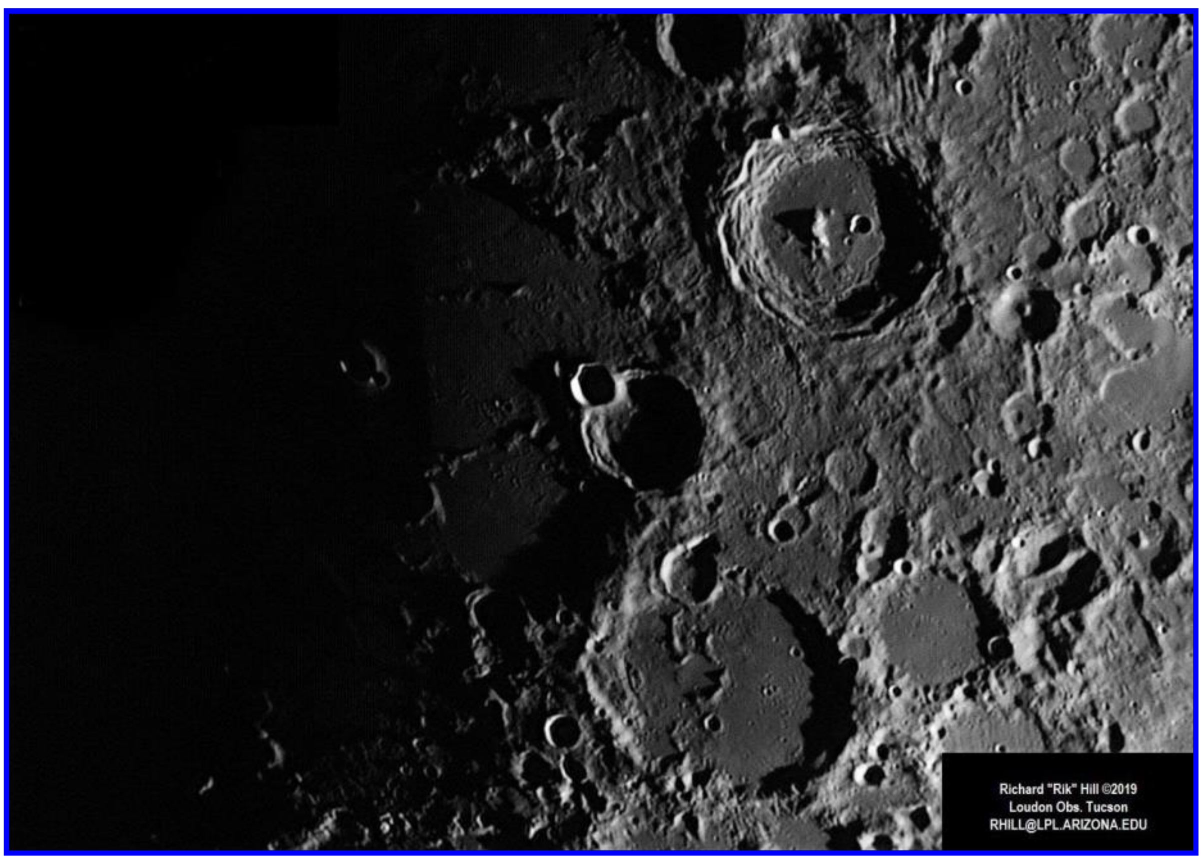
[11] Greenhagen, B.T., Lucey, P. G., Wyatt, M.B., Glotch, T. D., Allen,C.C., Arnold, J. A., Bandfield, J. L., Bowles, N. E., Donaldson Hanna, K. L., Hayne, P. O., Song, E., Thomas, I. R., Paige, D. A., 2010. Global Silicate Mineralogy of the Moon from the Diviner Lunar Radiometer. Science, 329, 1507-1509. doi: 10.1126/science.1192196.

A Bit of Thebit
Rik Hill

Here is another nice crater lost in the glory of all the surrounding spectacular landforms. In the center of this image can be seen the crater Thebit (60 km) with the smaller and much younger Thebit A (20 km) on its northwest wall. Thebit is full of shadow here but is a shallow crater with an interesting polygonal rima on the flat floor. Below or south of Thebit is one of the major distractions, Purbach (121 km) one of the older features on the moon with mauled walls to the west and north. the southeastern wall is part of the "Lunar X" seen best at a Colongitude of 359°, about a day earlier than this image. More of the X is made by La Caille (70 km) just east of Purbach, and Blanchinus (also 70 km) cut off by the nameplate of this image. I also enjoy Delaunay (48 km?) to the immediate northeast of La Caille that looks like a giant cloven hoof print!

Above Thebit is the remarkable crater Arzachel (100 km) with Rimae Arzachel on its floor. One of the larger of these rimae can be seen along the terminator shadow on the floor of this crater. This crater has wonderful terraced walls rivaling Copernicus. To the east are large north-south impact scars from "rocks" the size of cities that were ejected during the tremendous impacts that created the mare to the north.

To the west of Thebit a pair of craters can just be seen coming out of the shadows of the lunar night. The larger crater is Birt (17 km) and the smaller, as you might expect is Birt A, best known as the craters just west of the Great Wall or Rupes Recta which can just barely be made out in the deep shadows here. Below these on the south end of the rupes, are what used to be called the Stag's Horn Mountains. Unfortunately for us that grew up in the 1960s knowing them as such, they no longer officially bear that name.

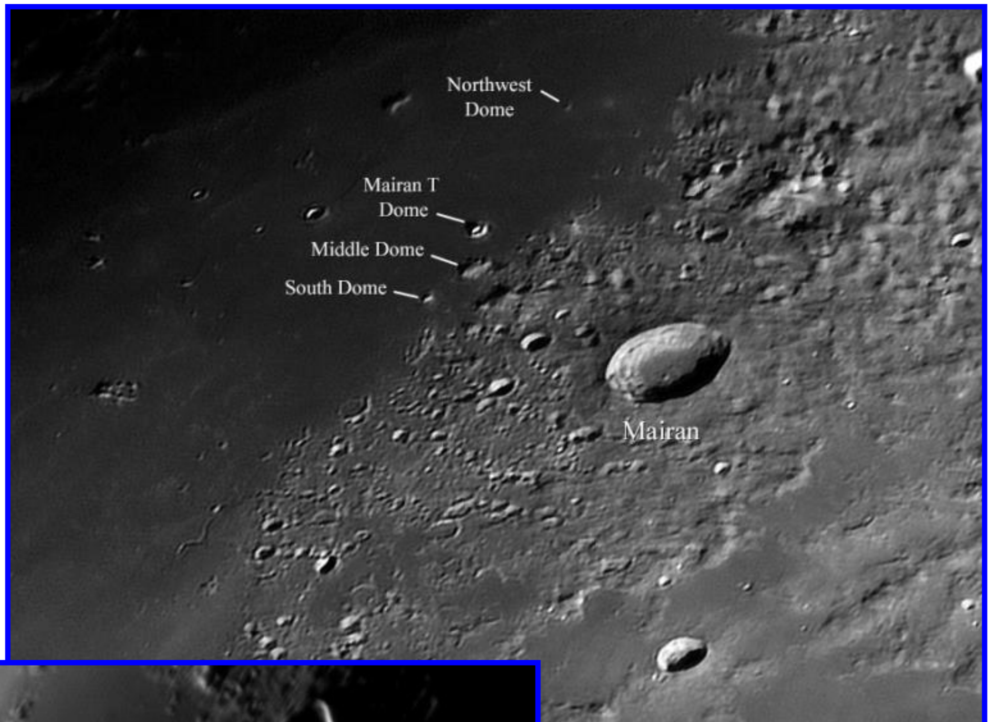


Thebit, *Richard Hill, Tucson, Arizona, USA. 07 October 2019 0142 UT, colongitude 9°. 8 inch f/20 Maksutov, f/20, Skyris 445M camera, 610 nm filter. Seeing 8/10.*

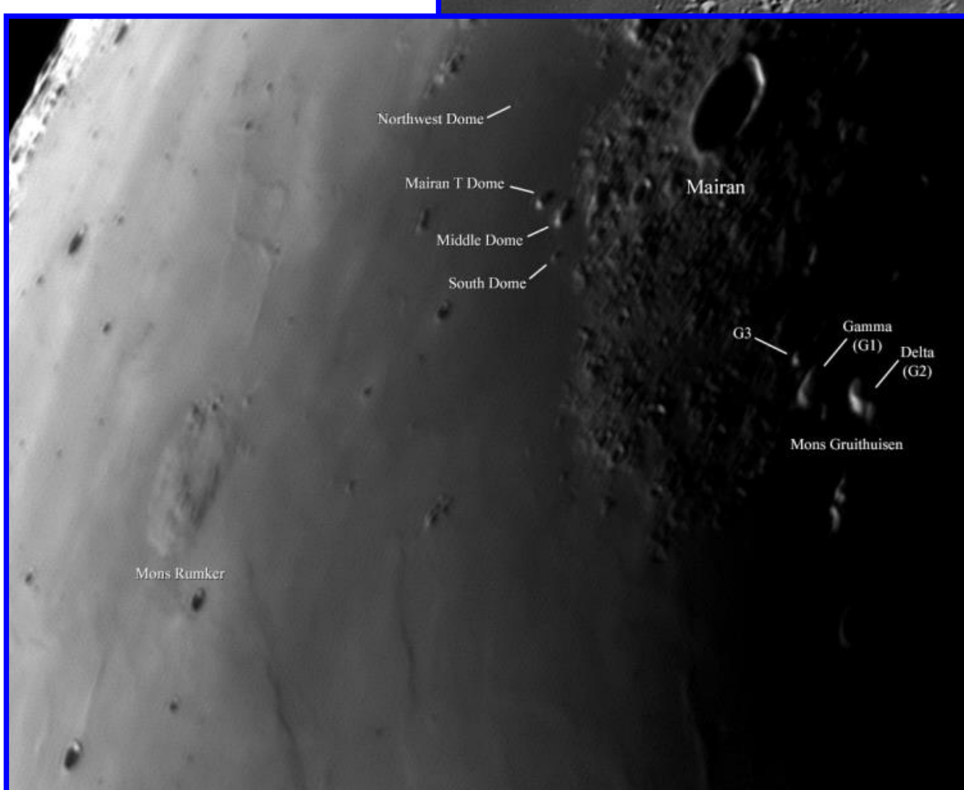
Mairan, Gruithuisen Domes and Mons Rumker

Howard Eskildsen

Here are some more dome images that were taken 13 days apart. This group of domes is rather unusual in that, except for Mons Rumker, the domes have a high silica content and were formed by more viscus lava than the maria. A very interesting discussion of the area, "The Mairan domes: Silicic volcanic constructs on the Moon Timothy D. Glotch, 1 Justin J. Hagerty, 2 Paul G. Lucey, 3 B. Ray Hawke, 3 Thomas A. Giguere, 3 Jessica A. Arnold, 1 Jean-Pierre Williams, 4 Bradley L. Jolliff, 5 and David A. Paige 4, Received 02 September 2011; revised 19 October 2011; accepted 19 October 2011; published 15 November 2011" can be viewed at:
https://luna1.diviner.ucla.edu/~dap/pubs/054.pdf. Also, the Gruithuisen domes are well summarized at: https://gruithuisen.blogspot.com//



Marian Domes, *Howard Eskildsen, Ocala, Florida, USA. 11 October 2019 0055 UT, colongitude 58º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 6/10, transparency 3/6.*



Marian T, Mons Rumker, *Howard Eskildsen, Ocala, Florida, USA. 24 October 2019 1012 UT, colongitude 220.9º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 5/10, Transparency 5/6.*

Lengthening Shadows

Rik Hill

Running almost diagonally from upper left to the lower right on the terminator is the beautiful Rupes Altai escarpment, seen here in the setting sun. It is part of the outer ring formed during the Mare Nectaris impact event and is thus concentric with Mare Nectaris (in shadow in the upper right). Notice the shadows from the 3-4 km high mountains in the middle, cast on the mare plain. On the southernmost end of this rupes is a barely discernible dark circle. This is Piccolomini (90 km) and above it on that same plain you can see Piccolomini 1 dome and a number of other dome-like structures.

Rupes Altai, *Richard Hill, Tucson, Arizona, USA. 18 October 2019 0072 UT, colongitude 149.8°. 8 inch f/20 Maksutov, f/20, Skyris 445M camera, 610 nm filter. Seeing 7/10.*

To the west (left) of Piccolomini are two sharply defined craters in a rough line. The first is Rothman (43 km) with an interestingly terraced wall and farther out Lindenau (54 km). Further west and a little south is a crater with two pairs of smaller craters on its floor. This is Rabbi Levi (83 km) named after a 14th century Jewish philosopher and scientist from Jerusalem hence the title "Rabbi" or teacher. North of this is a crater with a single small crater on its floor, Zagut (87 km). On the other end of Rupes Altai we see half of a large crater Catharina (104 km) part of the Theophilus trio to the north. Below this is the flat-bottomed crater Polybius (43 km). Just the other side of the rupes to the west is the similar sized Fermat (41 km) and below this crater is the well-worn Pons (46 km). These then, are some of the landmarks around the great Rupes Altai escarpment.

$R^2 = A^2 + B^2$ at Sunrise

David Teske

On the night of 10 November 2019, I was very pleasantly surprised to see the large, prominent crater Pythagoras north of Sinus Iridum on the terminator. What really caught my attention was the shadow of the central peaks thrown against the brilliant western wall of Pythagoras. Even more tantalizing was that the central peak, upon closer inspection, was not one peak but two. This inspired me to research this area. Named after the Greek philosopher Pythagoras who lived from 580 to 500 BC and forever immortalized by his famous formula, I find the diameter of this prominent, complex crater between 129 to 142 km. Similar to the structure of both Copernicus and Aristoteles, it would be a much more observed crater if it was not so close to the northwest limb. Having a rather hexagonal shape, its spectacular terraced walls soar 5 km above the arena-like floor. Two pyramid-shaped massive central peaks that rise 1.5 km lie next to one another on the crater floor. Formed in the Upper Imbrian age some 3.75 to 3.2 billion years ago, when an asteroid exploded into highland crust, the external impact structure so clearly seen around crater such as Copernicus are generally absent from the surroundings of Pythagoras.

In this image to the left of Pythagoras along the terminator is another shadow filled crater, Oenopides. Named after the Greek astronomer Oenopides who lived from 500 to 430 BC, this 67 to 73 km in diameter complex crater has its southwest wall almost completely destroyed by overlapping craterlets. Like many of the craters in this region that are in northern highlands, Oenopides is rather squared off due to gouging effects of ejecta from the formation of the Imbrium Basin formation.

Further southwest along the terminator from Oenopides is one more shadow-filled crater, Markov with a diameter of 40 km. This crater was named after Andrei Markov a Russian mathematician who lived from 1856 to 1922 and Alexander V. Markov, a Soviet astrophysicist who lived from 1897 to 1968.

The large, highly degraded crater that is between Oenopides and Pythagoras is Babbage. Named after Charles Babbage, the English mathematician who lived from 1792 to 1871, this complex crater seems to be a fusion of two craters that is 143 km across. Like much of the ancient region here, Babbage is a pre-Nectarian crater that is covered with ejecta from the Imbrium Basin formation. On its floor are the much fresher craters Babbage A with a diameter of 32 km and Babbage C with a diameter of 14 km.

South and adjacent to Babbage towards Mare Frigoris is another highly degraded crater named South. With a diameter of 108 km, South was named after James South, the English astronomer who lived from 1785 to 1867. Like other ancient craters in this area, its eroded walls are squared off. These walls may be squared off due to huge blocks striking the then circular rim areas with non-parallel or perpendicular blocks from the Imbrium Basin formation.

To the east or right of craters Babbage and South of the north shore of Mare Frigoris is the ancient giant crater J. Herschel. At 165 km across, this giant crater was named after the famous English astronomer who at the very same time as Babbage. As one of the Moon's near-side largest craters, J. Herschel is eroded and covered with rubble from the Imbrium impact. Its hilly floor has several small craters and is convexed upwards, perhaps from an additional debris from ejecta from Imbrium or volcanism that is underneath the crater.

North of J. Herschel can be found a linked group of large, flooded craters that show quite prominently at this time. Anaximander, named after the Greek philosopher who lived from 610 to 546 BC, is the crater with a diameter of 68 km rather in the center of this group. The lobe to the south of this nearly touching the crater J. Herschel id Anaximander D and the lobe towards the crater Pythagoras is Anaximander B. The much fresher looking crater superimposed on the Anaximander is Carpenter. At 60 km in diameter, this Copernican age crater with a diameter of 60 km was formed on Imbrium ejecta. Carpenter was named after James Carpenter, the English astronomer who lived from 1840 to 1899.

I end this foray in Mare Frigoris with the crisp young crater Harpalus. With a diameter of 39 km and named after the Greek astronomer who lived from 400 BC, this Eratosthenian age crater has nice terraces and a depth of 3.5 km. Careful inspection will show a faded ray system.

References

Chu, Alan, Wolfgang Paech, Mario Wigand & Storm Dunlop. 2012. The Cambridge Photographic Moon Atlas. Cambridge University Press, New York.

Grego, Peter. 2005. The Moon and How to Observe It. Springer-Verlag, London.

Kitt, Michael T. 1992. The Moon: An Observing Guide for Backyard Telescopes. Kalmbach Books, Waukesha.

Moore, John. 2014. Craters of the Near Side of the Moon.

Planck, Andrew. 2015. What's Hot on the Moon Tonight? Moonscape Publishing LLC.

North, Gerald. 2000. Observing the Moon. Cambridge University Press, Cambridge.

Rükl, Antonin: Atlas of the Moon, Kalmbach Books, 1990.

Pythagoras, *David Teske, Louisville, Mississippi, USA, 10 November 2019 at 0148 UT, colongitude 61.0^o. Seeing 7/10, 180 mm Takahashi Mewlon, ZWOASI120mms, 500 frames, Firecapture, Registax, Photoshop. Seeing 7/10.*

Craggy Morning

Rik Hill

Trying to catch all the different colongitudes for various regions on the Moon always leads to discoveries. Here we see the region bounced by Cassini (60 km) at top, shadow filled Calippus (34 km) to the right of it and Aristillus (56 km) just coming into light in the lower left with the splash pattern of its ejecta. Directly below Calippus you can see shallow Rima Calippus, usually very difficult to see with higher sun angles. Calippus sits in the middle of a range of mountains that runs diagonally across the lower right of this image, the Montes Caucasus. I have a particular fondness for this range for the way the mountains just seem to rise up out of the surrounding plain. In the center of the image is another shadow filled crater, Theaetetus (26 km). It sits at the head of an impressive unnamed valley that cuts through the Caucasus. What fun it would be to drive a rover the length of that valley! On the northwestern (upper left) flanks of these mountains are dramatic spiky shadows pointing back to Cassini. Note the fine cliff to the wet of Calippus.

Cassini to Caucasus, *Richard Hill, Tucson, Arizona, USA. 06 October 2019 0130 UT, colongitude 355.5°. 8 inch f/20 Maksutov, f/20, Skyris 445M camera, 665 nm filter. Seeing 8/10.*

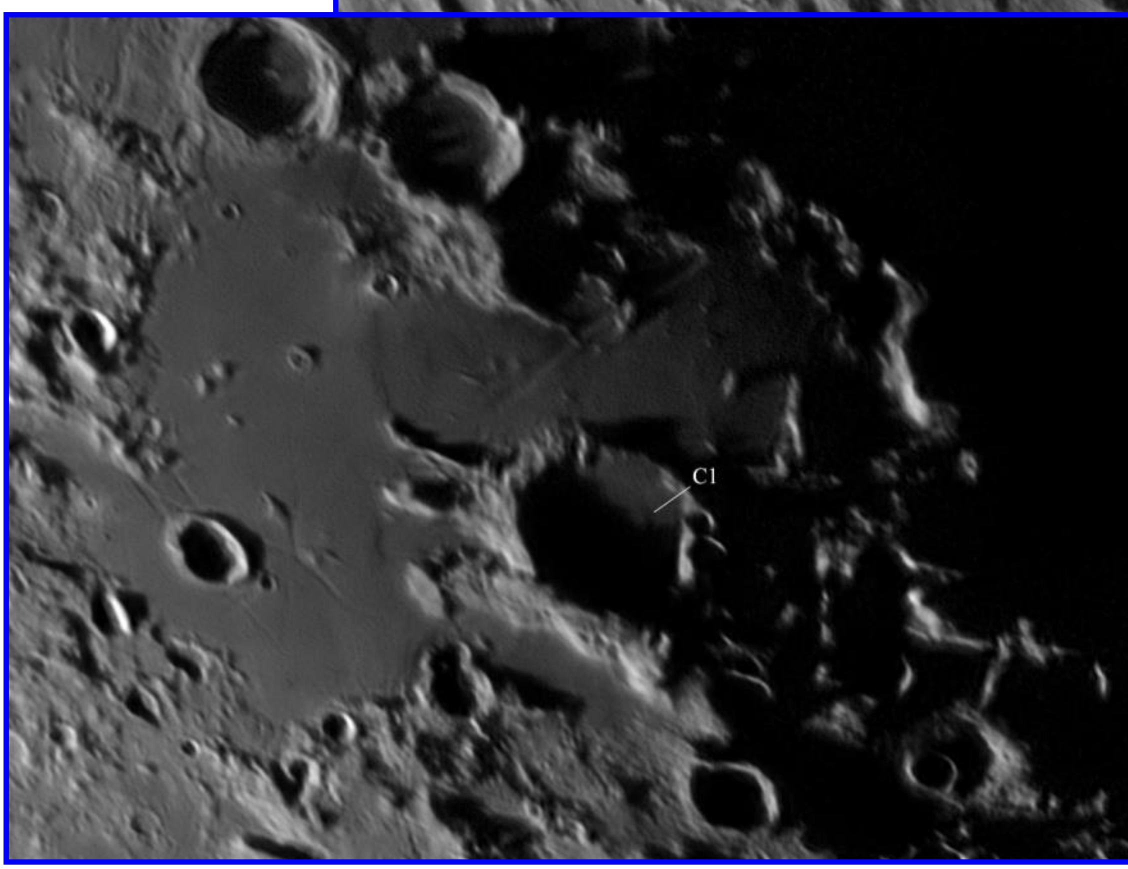
On the floor of Cassini, we see Cassini A (17 km) and to the left of it, Cassini B (9 km). The ejecta to the east of Cassini forms a wonderful rumpled apron. Lastly above the name plate we see the ramparts of Mons Piton (alt. 2250 m) catching the first rays of the morning sun.

Capuanus Dome 1

Howard Eskildsen

This morning the seeing was better, but variable, and seemed to get worse when our heat pump turned on, so I deactivated it for a time. I imaged the area twice in hopes of a good picture since the seeing was variable These two images were taken 16 minutes apart and shows Capuanus Dome 1 (Ca1), which is marked on both images. The region of Capuanus Dome 2 (Ca2) is marked on the first image, but I think the dimple of a shadow near that dome is cast from the rim, rather than from Ca2.

__Capuanus Domes__, Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1104 UT, colongitude 202.2º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 5-6/10, transparency 5/6.



__Capuanus Domes__, Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1120 UT, colongitude 202.3º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 5-6/10, transparency 5/6.

The Moon Through a 9.5" f/15 Alvin Clark Refractor!

Mons Herodotus, *John D. Sabia, Keystone College, Thomas G. Cupillari Observatory, Fleetville, Pennsylvania, USA. 09 November 2019 0145 UT, colongitude 51.64°. 9.5 inch f/15 Alvin Clark refractor, 2.5 x barlow, Canon T5 camera. Seeing 6/10.*

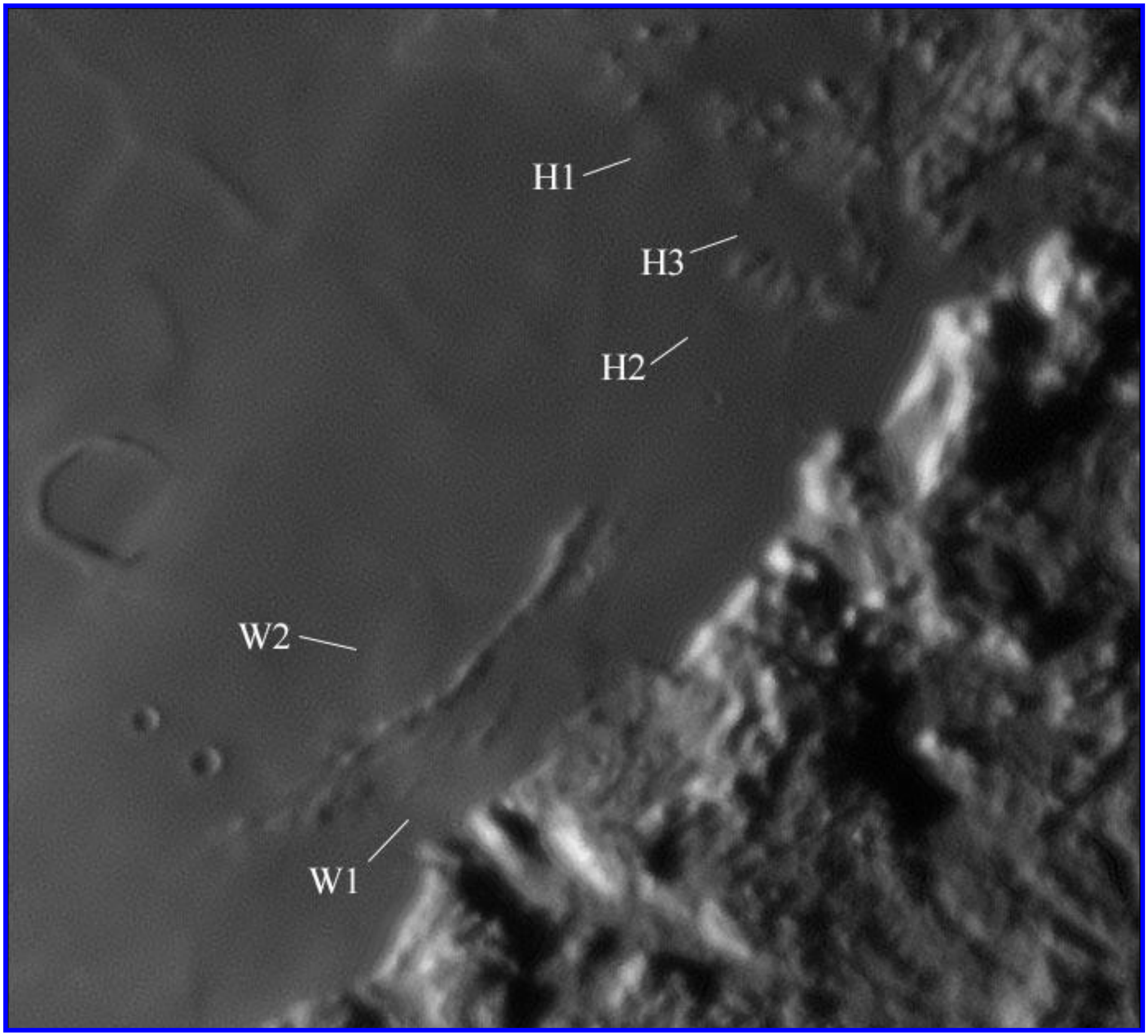
"The brightness of Mon Herodotus was remarkable visible sight in the eyepieces view. Never had I seen such a brightly light mountain peak over the terminator. This was a most impressive sight using a 21 mm eyepiece on the telescope."

Gassendi and Mare Humorum, *John D. Sabia, Keystone College, Thomas G. Cupillari Observatory, Fleetville, Pennsylvania, USA. 08 November 2019 1925 UT, colongitude 50.92°. 9.5 inch f/15 Alvin Clark refractor, 2.5 x barlow, Canon T5 camera. Seeing 6/10.*

Wallace and Huxley Domes

Howard Eskildsen

Wallace and Huxley domes are indicated on this image by W and H respectively followed by numbering based on an image posted at http://www.chamaeleon-observatory-onjala.de/mondatlas-en/bilder-vulkanismus/s08/s8b/8-5-tage/huxley-wallace-23-06-07_18-37+18-37+18-41.png by Franz Hoffman and Wolfgang Paech of Chameleon Observatory. The W1 and W2 domes appear to be part of the same complex on my image, but this may be due to poor seeing conditions at the time. I look forward to getting more images of this fascinating area.

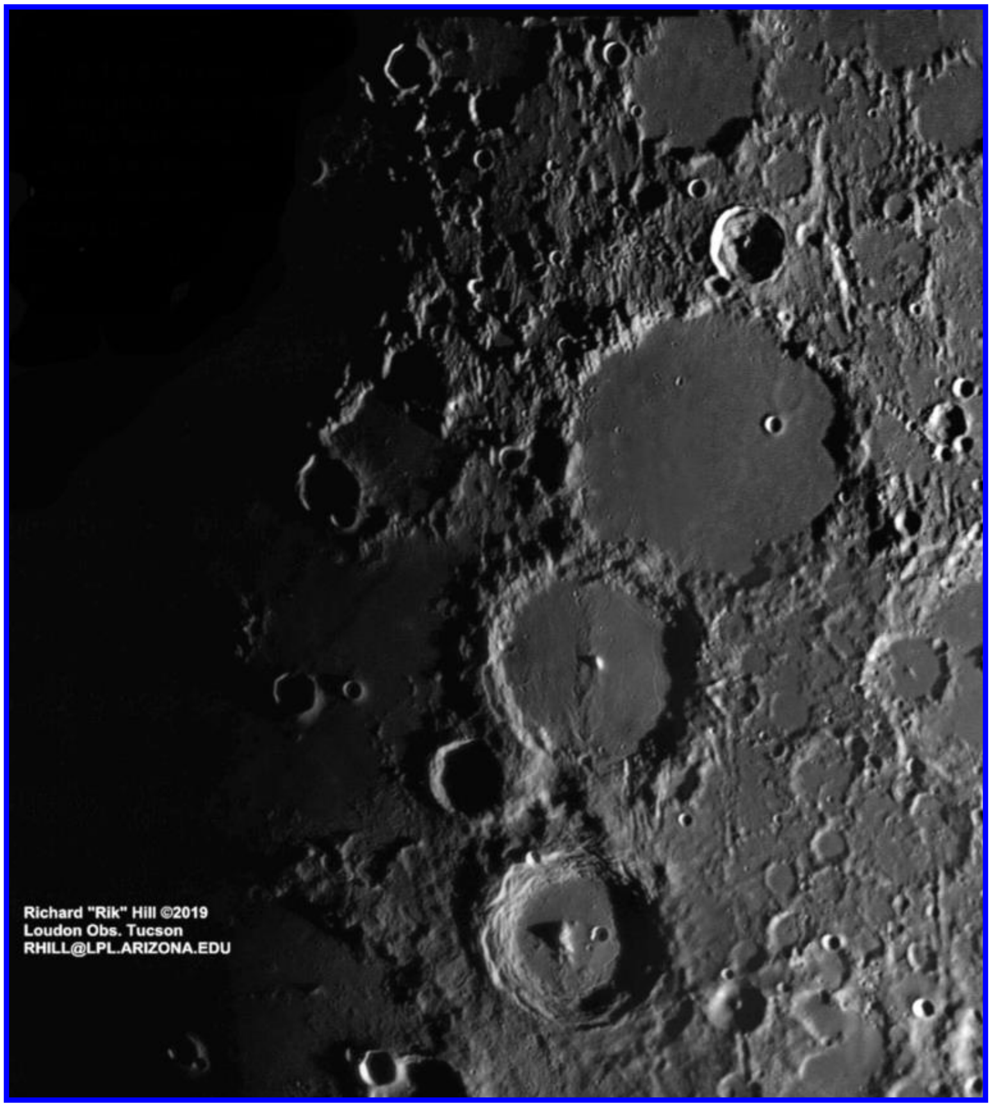


Wallace and Huxley Domes, *Howard Eskildsen, Ocala, Florida, USA. 19 November 2019 1135 UT, colongitude 178.1°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 4/10, transparency 5/6.*

Central Trio
Rik Hill

It’s always breathtaking when you look at the 8-day old moon and see this trio of craters right there on the terminator. I spent many hours looking at them with my 60mm Tasco refractor back in the early 1960s. The largest is Ptolemaeus (158 km) a flooded crater we used to call a "walled plain". On the floor is the crater Ammonius (9 km) which in those old days was Lyot before it was changed. This was a crater I could pick out with that little 'scope but across Ptolemaeus is the smaller Ptolemaeus D (4 km) which was a true challenge for that telescope in the hands of a tyro.

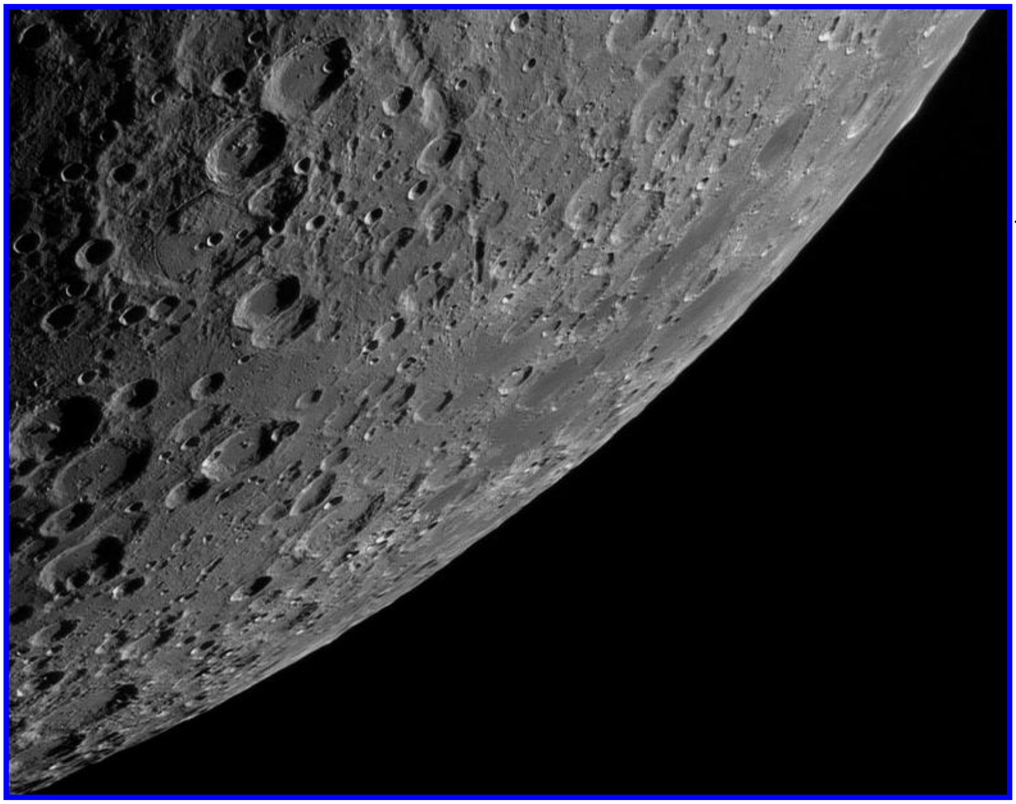
To the south is Alphonsus (121 km) the target of Ranger 9 back in 1965. I stayed up late with my Dad the night it impacted and we watched the images coming back. It was an exciting time. Note the rimae on the floor of Alphonsus. The dorsum running down the center has wonderful detail in it. Then the next crater south is Arzachel (100 km) with its impressive off-center central peak next to the small crater Arzachel A (10 km). The central peak looks like a cliff face just jutting straight up out of the surrounding territory.



Arzachel to Flammarion, *Richard Hill, Tucson, Arizona, USA. 07 October 2019 0144 UT, colongitude 9º. 8 inch f/20 Maksutov, f/20, Skyris 445M camera, 665 nm filter. Seeing 8/10.*

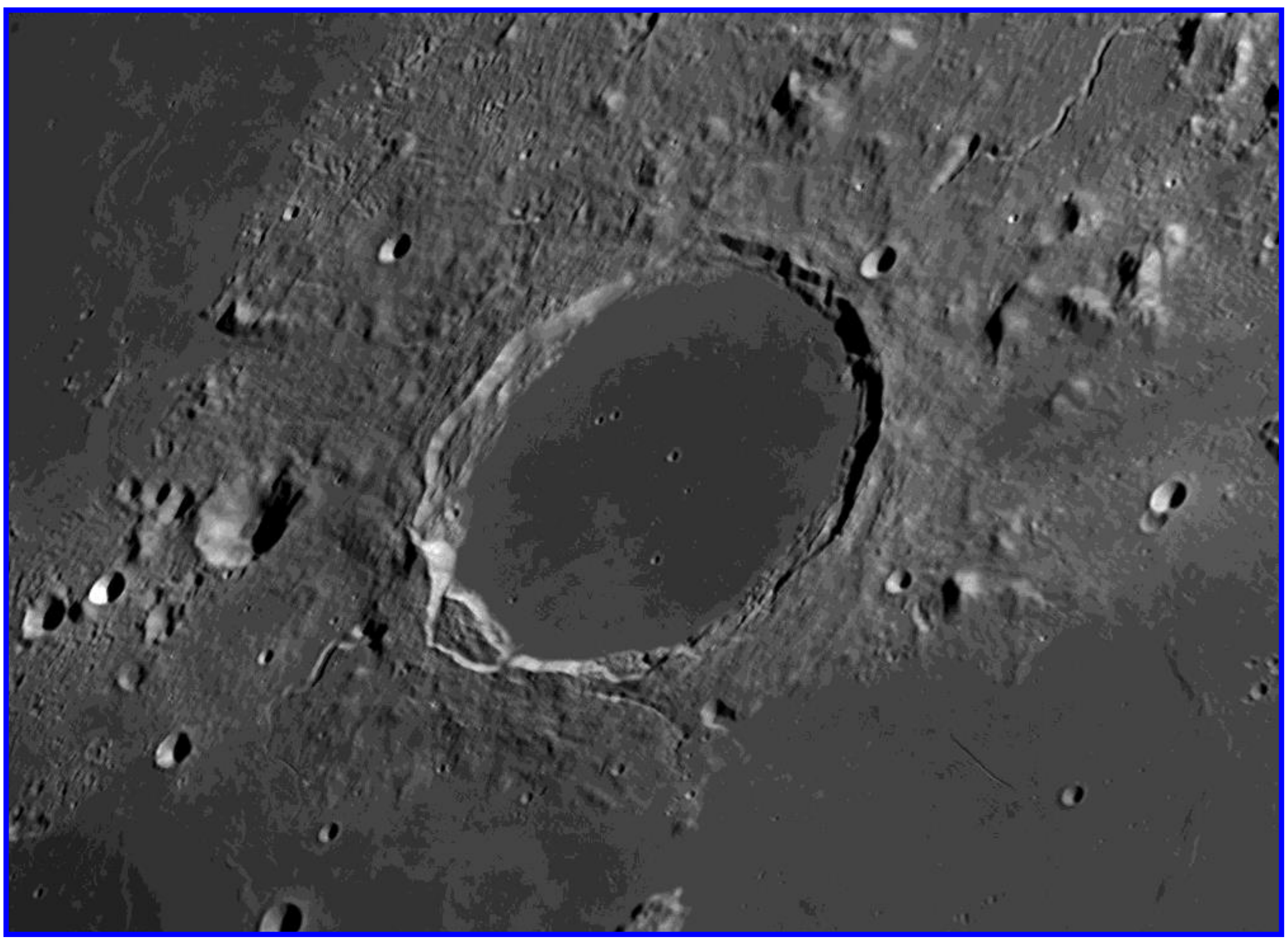
North of Ptolemaeus is the relatively young crater Herschel (43 km) and just above it is the smaller Spörer (29 km) ending with Flammarion (77 km), the author of one of my first astronomy books, Popular Astronomy. Before leaving notice the big nearly vertical scars to the right of all these craters. These were gouged out by city sized rocks ejected during the Imbrium impact event!

Recent Topographic Studies

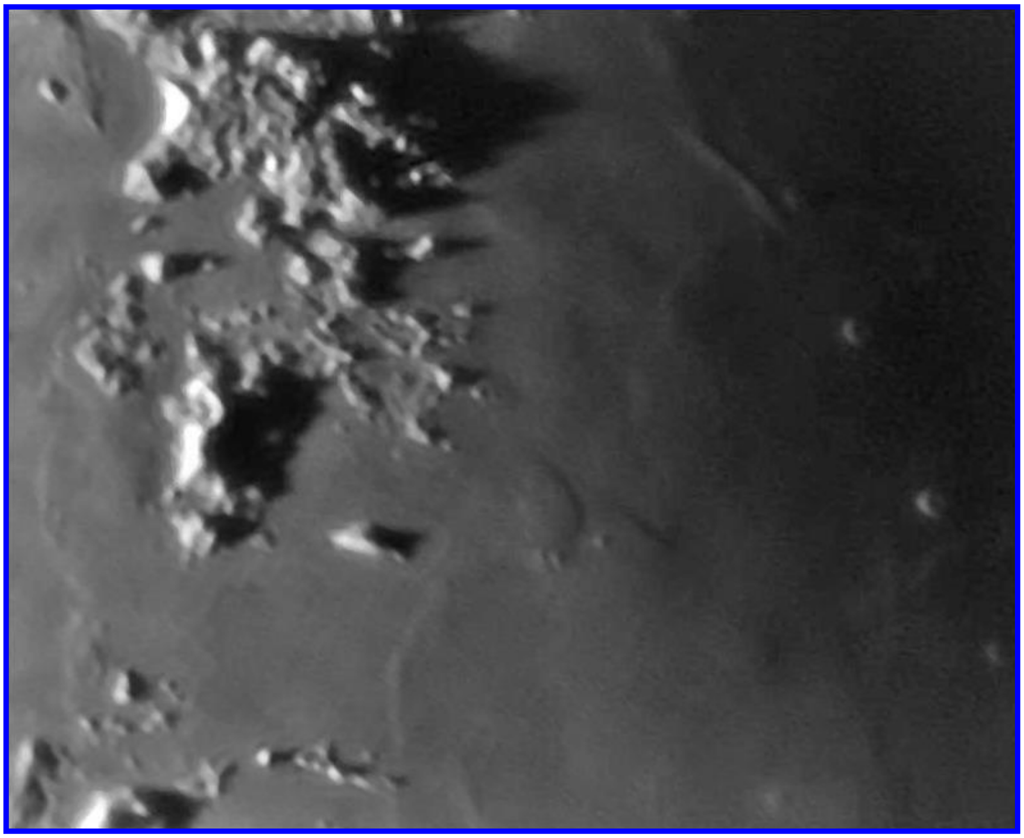


Mare Australe, *Howard Eskildsen, Ocala, Florida, USA. 03 October 2019 2359 UT, colongitude 332.2°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, W-25 red filter, DMK 41AU02.AS camera. Seeing 5/10, transparency 5/6.*

Plato*, Damian Peach. 11 November 2019. 1 m telescope ASI 174 camera.*



Recent Topographic Studies



Valentine Dome, *Howard Eskildsen, Ocala, Florida, USA. 18 November 2019 1151 UT, colongitude 166.1º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 3-4/10, transparency 2/6.*

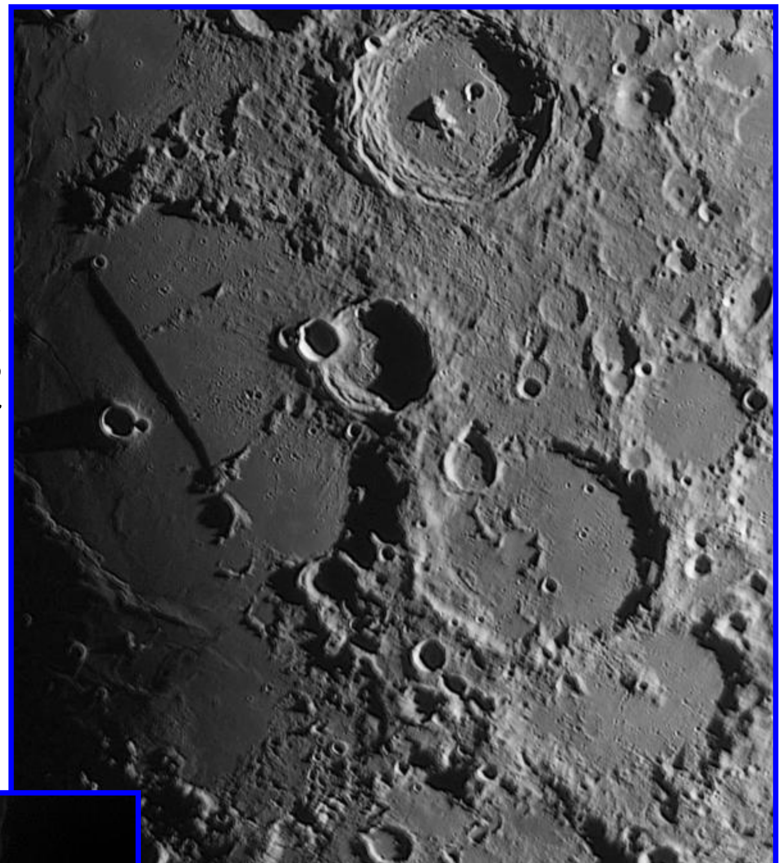
Werner, *Jairo Chavez Popayán, Colombia. 05 November 2019 0033 UT. 10" truss Dobsonian telescope, MOTO ES PLAY.*

Recent Topographic Studies

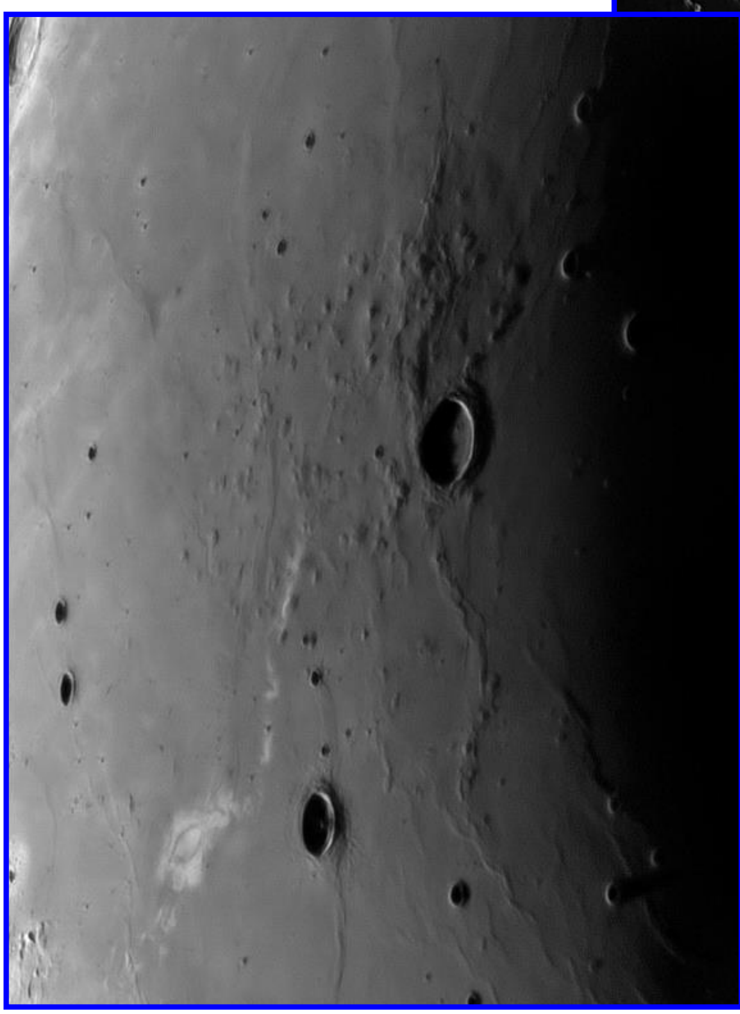
Palus Putredinus Dome-1, *Howard Eskildsen, Ocala, Florida, USA. 19 November 2019 1136 UT, colongitude 178.1°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2,395 mm, 2 x barlow, W-25 red filter, DMK 41AU2.AS camera. Seeing 4/10, transparency 5/6.*

Alphonsus, *Desiré Godoy, Oro Verde, Argentina. 08 November 2019 0104 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*

Recent Topographic Studies

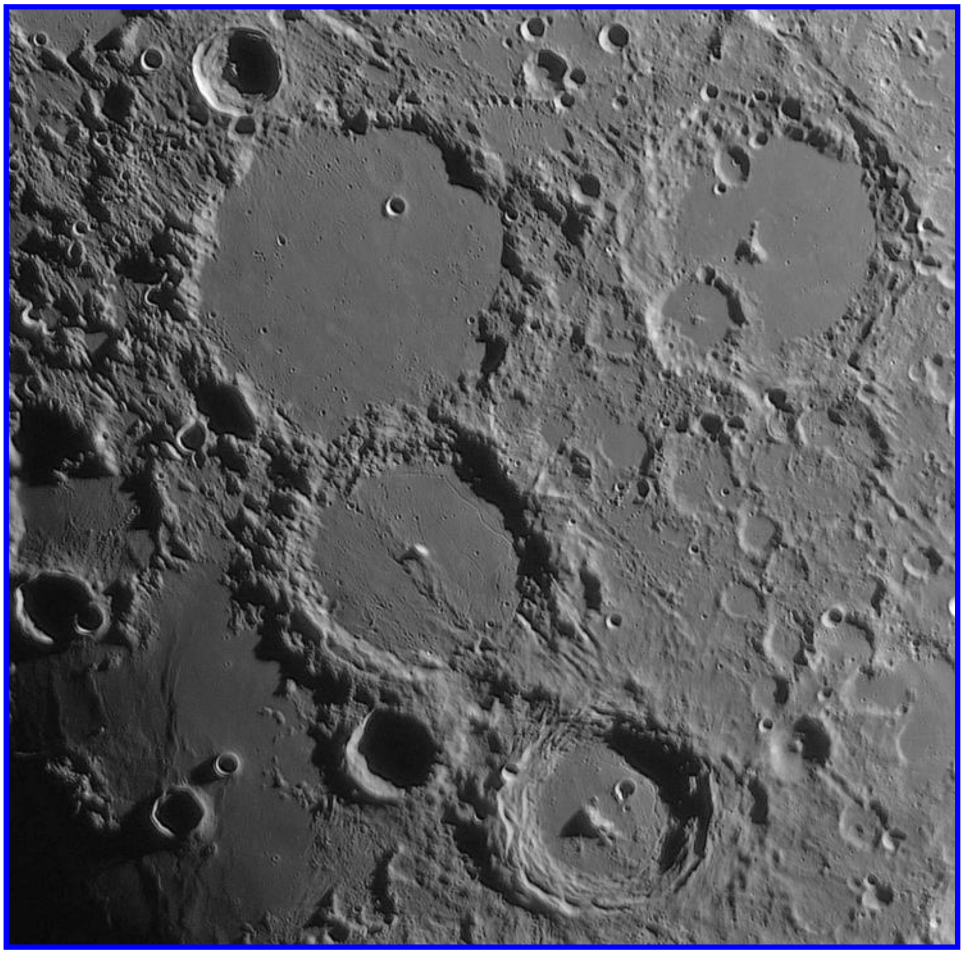


Arzachel, Rupes Recta and Purbach , *Luigi Morrone, Agerola, Italy. 21 June 2018 1952 UT. Celestron 11 SCT, 280 mm, Fornax Mount, ZWO ASI 178M camera, barlow Zeiss Abbe, Baader R+IR filter 610 nm.*



Marius Domes, *Howard Eskildsen, Ocala, Florida, USA. 23 November 2019 1137 UT, colongitude 226.8°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 7/10, transparency 4/6. Two image composite.*

Recent Topographic Studies

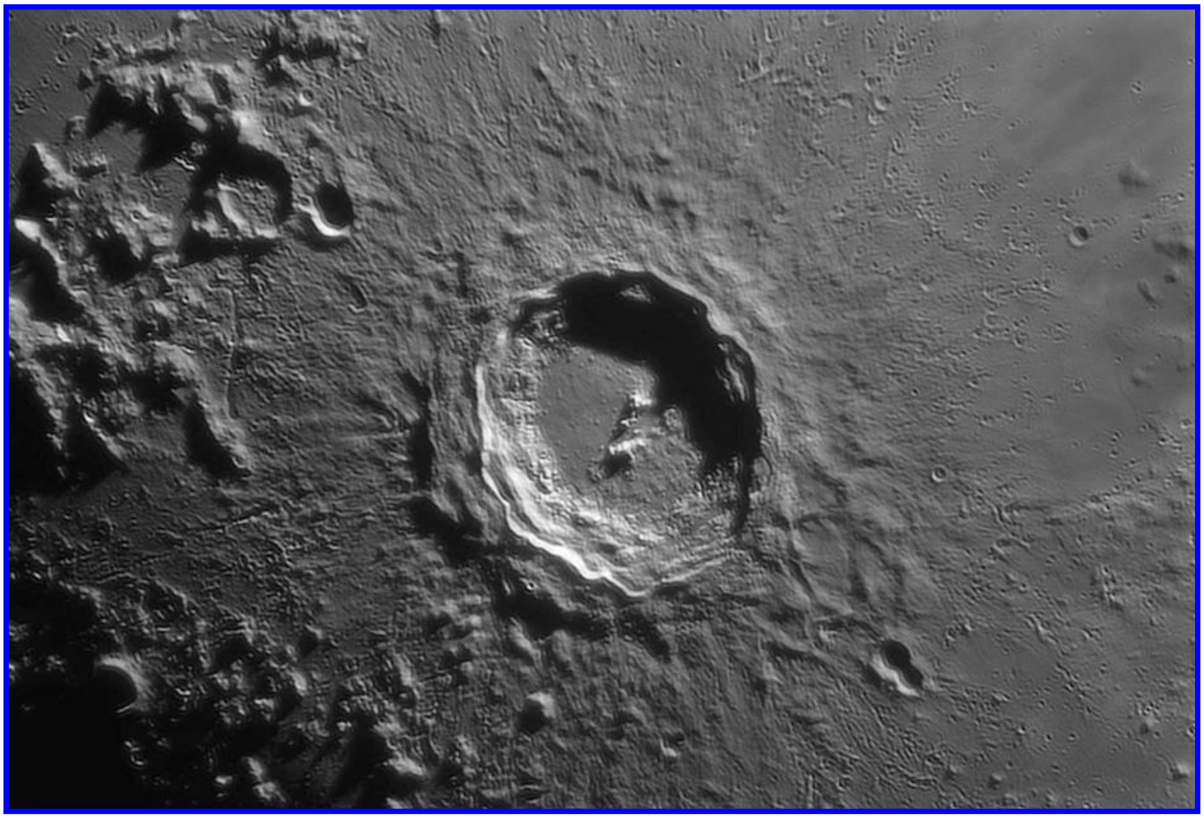


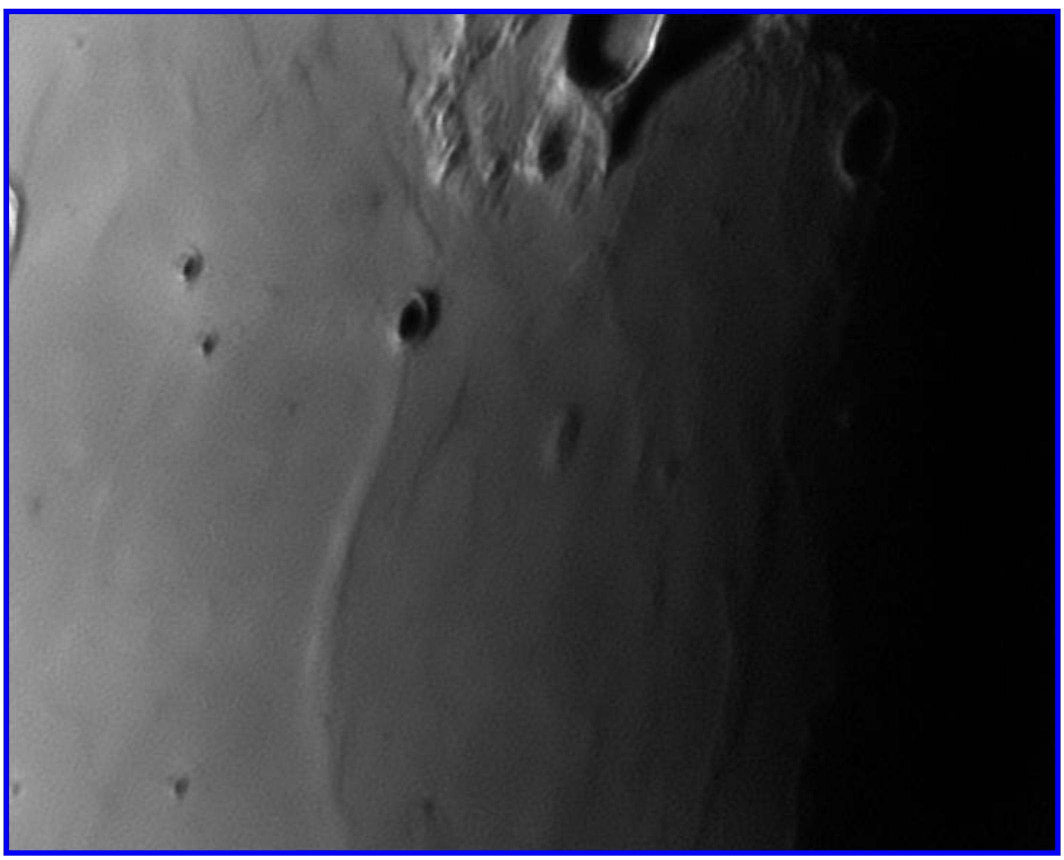
Alphonsus, Arzachel and Ptolemaeus, *Luigi Morrone, Agerola, Italy. 23 April 2018 1906 UT. Celestron 11 SCT, 280 mm, Fornax Mount, ZWO ASI 178M camera, barlow Zeiss Abbe, Baader R+IR filter 610 nm. Seeing 7/10, transparency 8/10.*

Tycho*, Desiré Godoy, Oro Verde, Argentina. 08 November 2019 0106 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*

Recent Topographic Studies

Copernicus, *Luigi Morrone, Agerola, Italy. 05 May 2017 1925 UT. Celestron 11 SCT, 280 mm, Az-NEQ6 Pro, ZWO ASI 174M camera, barlow Zeiss Abbe, EFL 8,850 mm, Baader R+IR filter 610 nm. Seeing 7/10, transparency 8/10.*

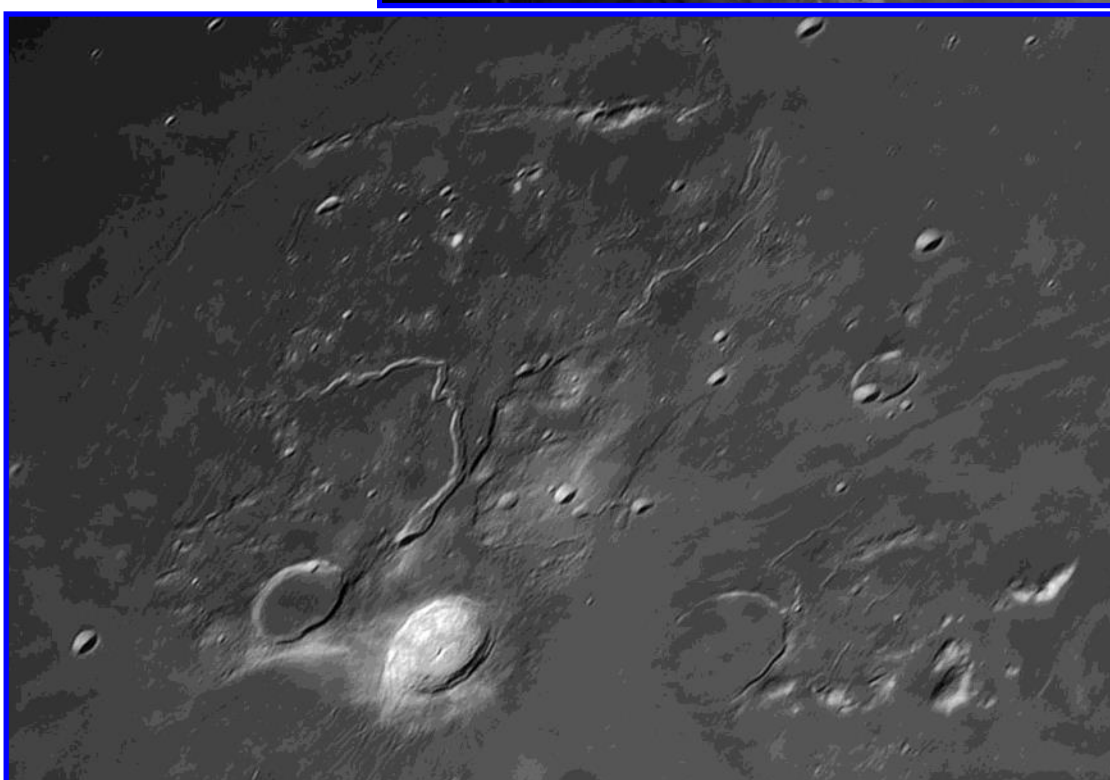




Herodotus Omega Dome, *Howard Eskildsen, Ocala, Florida, USA. 23 November 2019 1134 UT, colongitude 226.8°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 7/10, transparency 4/6.*

Recent Topographic Studies

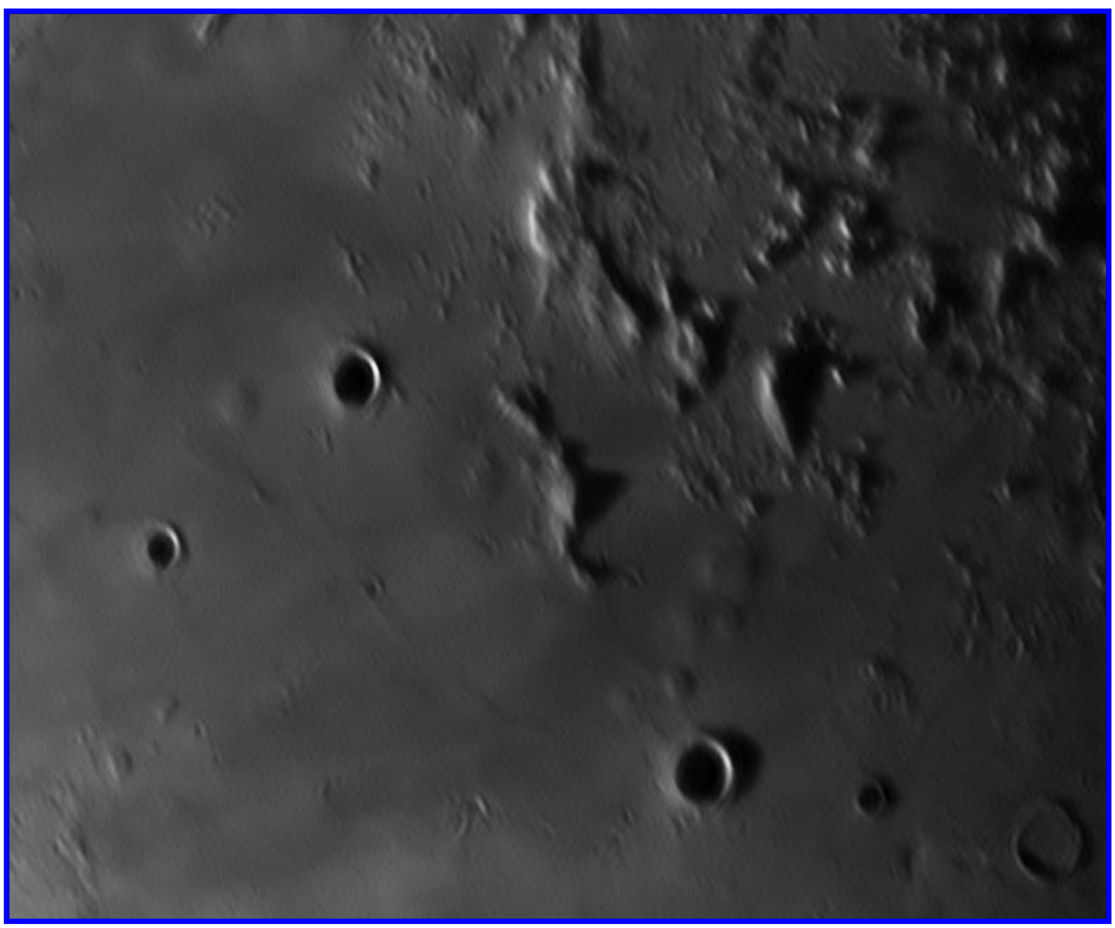
Mare Serenitatis*, Jairo Chavez Popayán, Colombia. 05 November 2019 0039 UT. 10" truss Dobsonian telescope, MOTO ES PLAY.*



Aristarchus and Vallis Schroteri, *Luigi Morrone, Agerola, Italy. 11 October 2019 2035 UT. Celestron 14 Edge SCT, 355 mm, Fornax Mount, ZWO ASI 178M camera, Baader R+IR filter 610 nm.*

Recent Topographic Studies

T. Mayer Domes, *Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1124 UT, colongitude 202.3°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 5-6/10, transparency 5/6.*



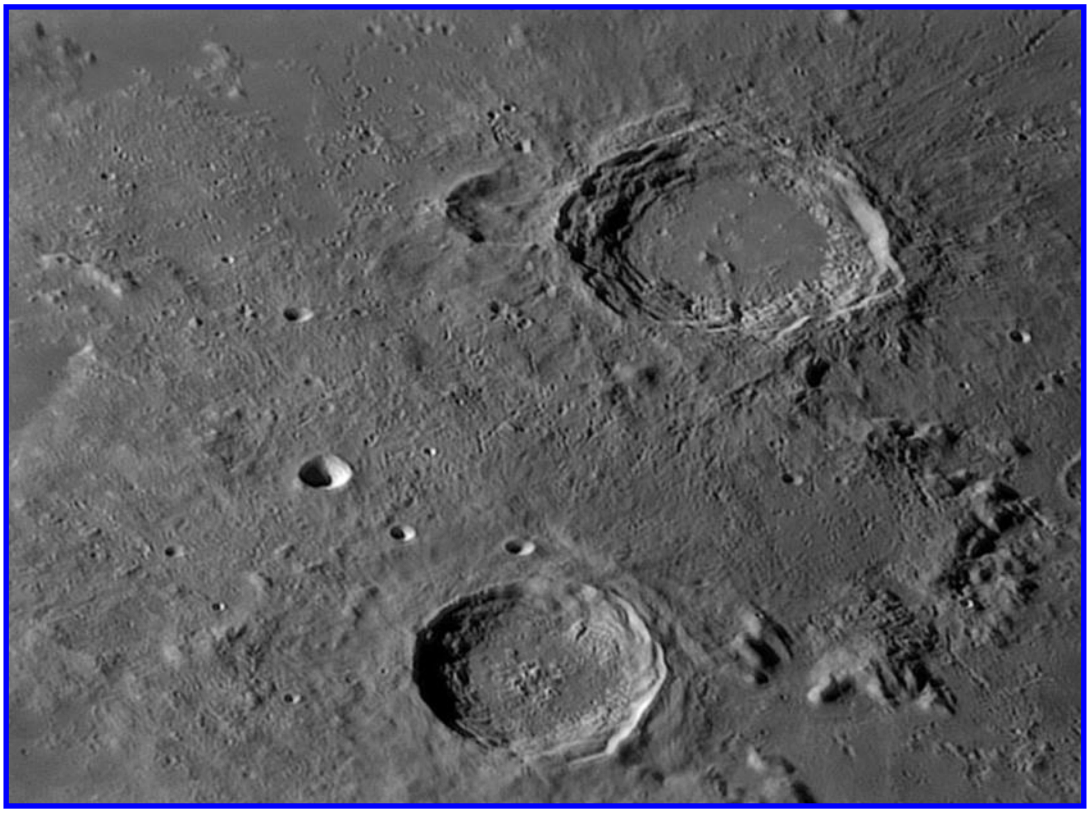
Hortensius, Milichius Domes, *Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1125 UT, colongitude 202.3°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 5-6/10, transparency 5/6.*

Recent Topographic Studies

Aristillus, *Jairo Chavez Popayán, Colombia . 05 November 2019 0039 UT. 10" truss Dobsonian telescope, MOTO ES PLAY.*

Theophilus, *Desiré Godoy, Oro Verde, Argentina. 08 November 2019 0120 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*

Recent Topographic Studies



Aristoteles and Eudoxus, *Luigi Morrone, Agerola, Italy. 23 April 2018 1835 UT. Celestron 11 SCT, 280 mm, Fornax Mount, ZWO ASI 178M camera, barlow Zeiss Abbe, Baader R+IR filter 610 nm. Seeing 7/10, transparency 8/10.*

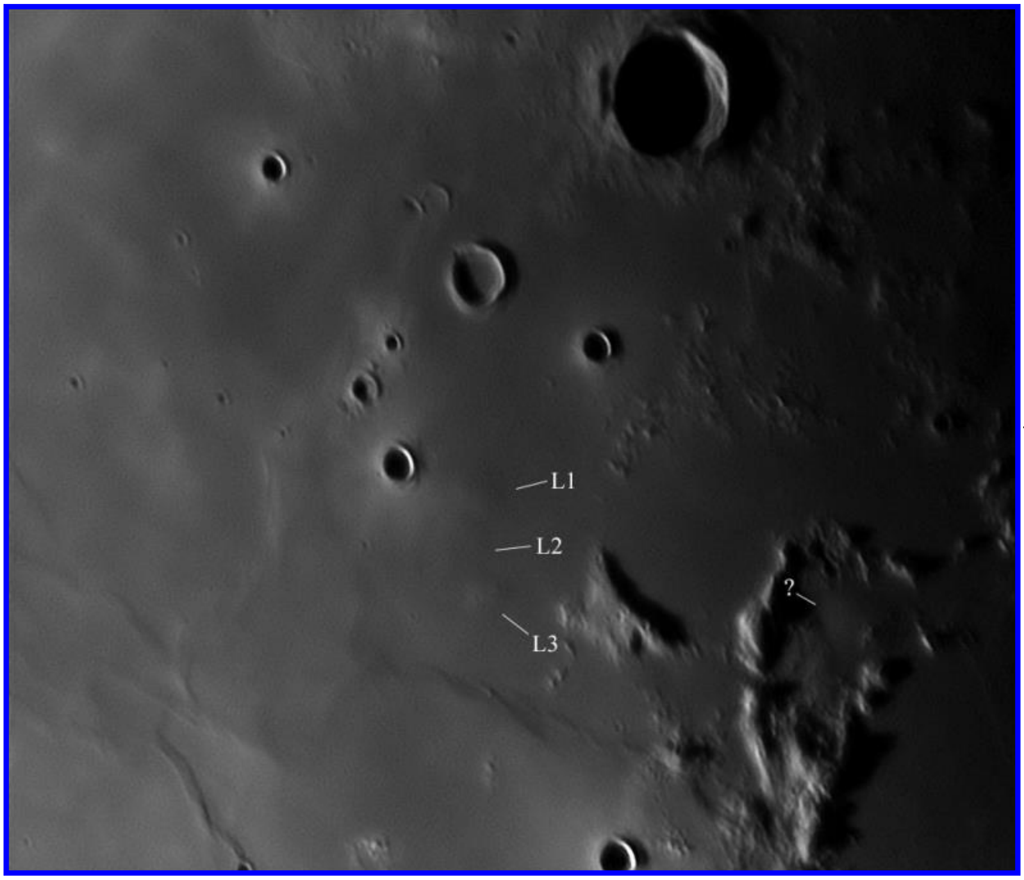
Proclus*, Desiré Godoy, Oro Verde, Argentina. 08 November 2019 0122 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*

Recent Topographic Studies

***Langrenus**, Desiré Godoy, Oro Verde, Argentina. 08 November 2019 0128 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*

***Waxing Gibbous Moon**, Jairo Chavez Popayán, Colombia. 07 November 2019 2328 UT. 10" truss Dobsonian telescope, MOTO ES PLAY.*

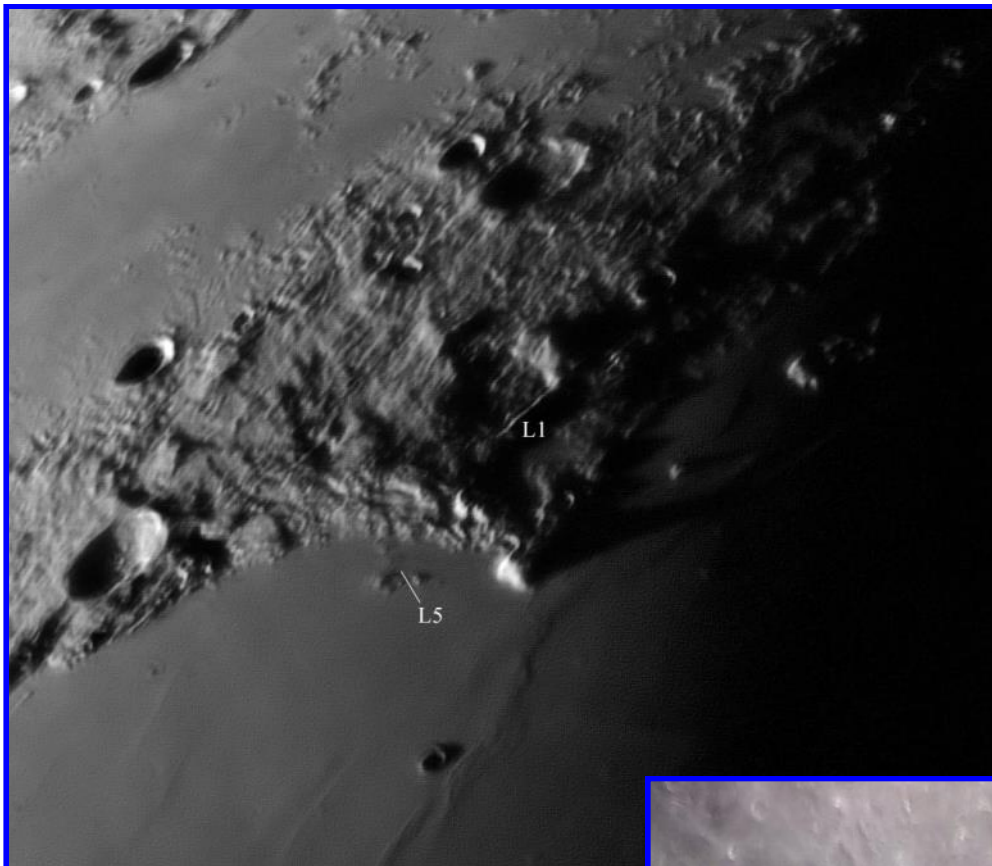
Recent Topographic Studies



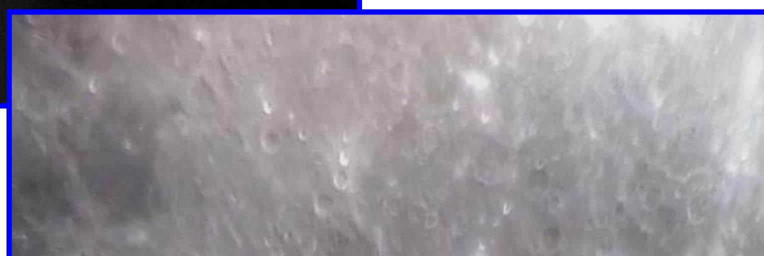
Lansberg D Domes, *Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1127 UT, colongitude 202.4°. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W -25 red filter, DMK 41AU02.AS camera. Seeing 5-6/10, transparency 5/6.*

Atlas and Hercules, *Luigi Morrone, Agerola, Italy. 10 May 2019 1919 UT. Celestron 14 Edge SCT, 355 mm, Fornax Mount, ZWO ASI 178M camera, barlow Zeiss Abbe, Baader R+IR filter 610 nm.*

Recent Topographic Studies

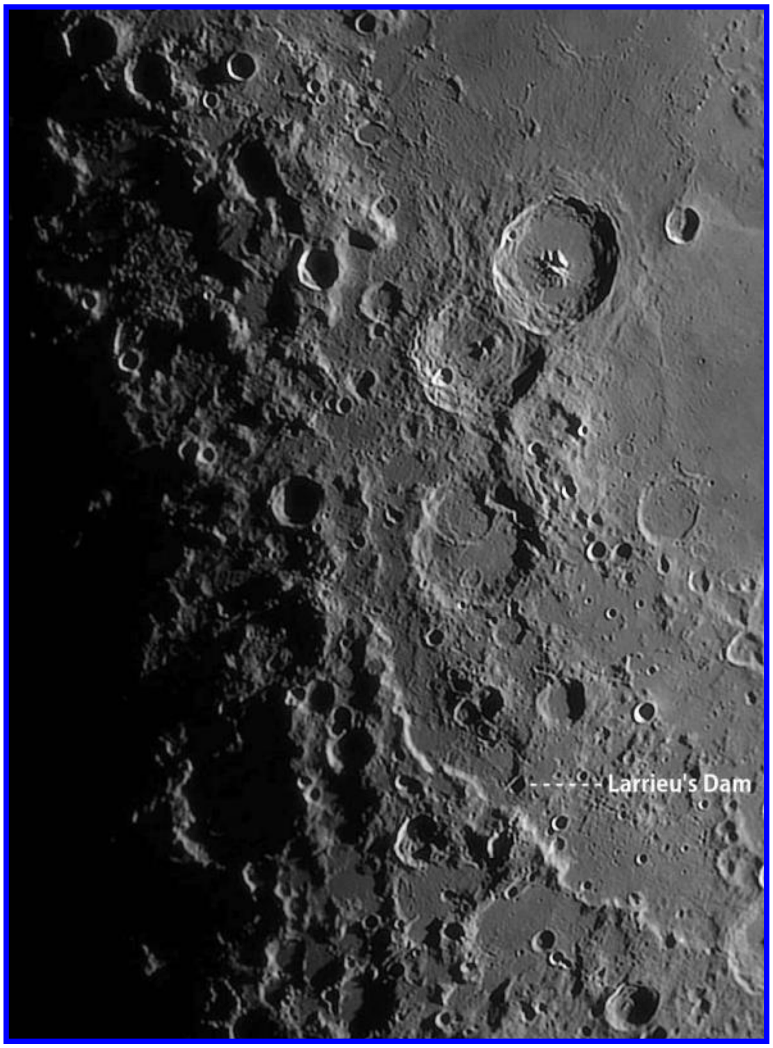


Promontorium Laplace Dome 5, *Howard Eskildsen, Ocala, Florida, USA. 21 November 2019 1106 UT, colongitude 202.1º. 9.25 inch Schmidt-Cassegrain, f/10, fl 2395 mm, 2 x barlow, W-25 red filter, DMK 41AU02.AS camera. Seeing 5-6/10, transparency 5/6.*



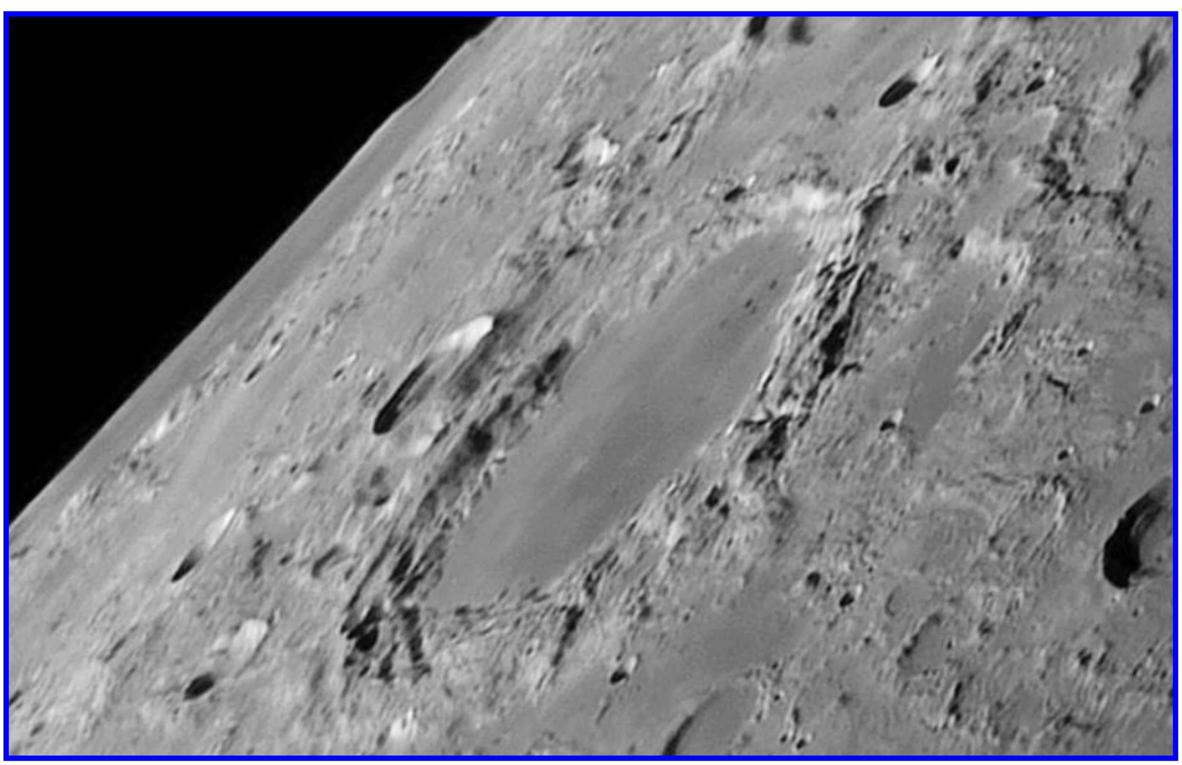
***Tycho**, Jairo Chavez Popayán, Colombia. 05 November 2019 0037 UT. 10" truss Dobsonian telescope, MOTO ES PLAY.*

Recent Topographic Studies



Theophilus-Rupes Altai-Larrieu's Dam, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 05 August 2019 0238 UT. 4 inch achromatic refractor at f/20 Skyris 132M camera, Orion IR cut off filter. Seeing 7-8/10, transparency 3/6.*

Endymion, *Luigi Morrone, Agerola, Italy. 10 May 2019 1924 UT. Celestron 14 Edge SCT, 355 mm, Fornax Mount, ZWO ASI 178M camera, barlow Zeiss Abbe, Baader R+IR filter 610 nm.*



LUNAR GEOLOGICAL CHANGE DETECTION PROGRAM

Coordinator – Dr. Anthony Cook – atc@aber.ac.uk
Assistant Coordinator – David O. Darling - DOD121252@aol.com

2019 December

Firstly, I would like to read our readers a happy holiday over the Christmas period with plenty of clear sky. Reports have been received from the following observers for Oct: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Cepheus A, Grimaldi, Kepler, Menelaus, Theophilus and imaged several features. Alberto Anunziato (Argentina – SLA) observed Alphonsus, Censorinus, Mons Piton, Swift, Plato and Ross D. Aylen Borgatello (Argentina – AEA) imaged Alphonsus and Ross D. Anthony Cook (Newtown, UK – ALPO/BAA) videoed several features. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Alphonsus, Aristarchus, Aristillus, Blanchinus, Copernicus, Darwin, Eddington, Gassendi, Grimaldi, Heraclitus, Plato, Pythagoras, Schickard, Triesnecker, Tycho, Vallis Alpes, and took some whole lunar disk images. John Duchek (Carrizozo, NM, USA - ALPO) imaged Copernicus, Walter Elias (Argentina – AEA) imaged: Mare Crisium Mons Piton, Pitiscus and Swift. Valerio Fontani (Italy – UAI) imaged Briggs. Victoria Gomez (Argentina – AEA) imaged Purbach. Facundo Gramer (Argentina – UAI) imaged Mare Crisium and Plato. Rik Hill (Tucson, USA – ALPO) imaged Aristoteles, Barrow, Rupes Altai, Thebit, Theophilus, and several features. Thierry Speth (France – BAA) imaged Aristarchus, Grimaldi, and Herodotus. Franco Taccogna (Italy – UAI) imaged the Full Moon. Aldo Tonon (Italy – UAI) imaged Briggs. Alan Trumper (Argentina – AEA) imaged Montes Appeninus and Snellius. Ivan Walton (Cranbrook, UK – BAA) imaged Alphonsus and Aristarchus.

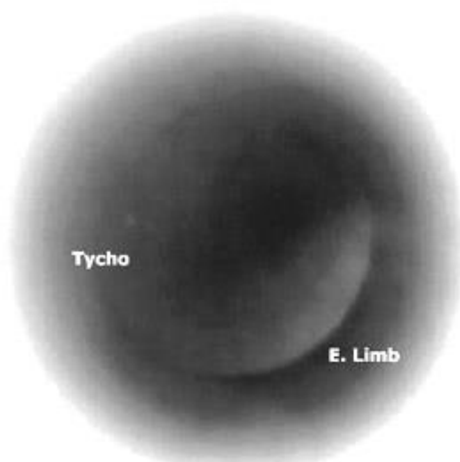


Figure 1. Thermal IR image of the Moon captured by Anthony Cook during the 2007 Mar 03 lunar eclipse at 22:25 UT. White is hot and dark is cool.

News: This newsletter is published both by ALPO's The Lunar Observer (TLO) and the BAA's Lunar Section Circular (LSC). BAA readers may be interested in some articles published in the TLO recently namely Thermal IR measurements from ALPO observer Darryl Williams in the Sep and Nov 2019 TLO. I wanted to highlight this as thermal imaging has come a long way since professional astronomers did this in the 1960's using scanning bolometers, and a brief experiment I mentioned in the April 2007 newsletter capturing the heat radiating away from large boulder sized ejecta blocks outside Tycho during a lunar Eclipse (Fig 1). Fig 1 was made with an Indigo Omega (sometimes known as a ThermoVision™ A10) camera operating at Newtonian focus on an 8" reflector. The camera can in theory measure temperature differences as small as 0.1C, but in the unconventional way that I used it, the precise sensitivity is probably much poorer. The image size was only 160x128 pixels and the camera had a fixed focus lens that I could not remove. Such cameras cannot see through ordinary glass so I had to improvise and use a spare Germanium lens as an eyepiece for eyepiece projection. The set up was far from ideal as the telescope mirror was aluminium coated instead of the more traditional gold coating that one finds on professional scopes, and I had heat radiating off the telescope tube and the sides of the draw tube – hence why the image has the white border around it. Furthermore, I had to turn the automated calibration and flat fielding off once the Moon was well into the eclipse as the heat from the Moon was fading fast and the telescope heat started to dominate. Anyway, despite this I was able to detect the radiated heat from the Moon falling away quickly once the penumbra, and umbra started to cover. What was really fascinating for me was how Tycho sits there glowing hot, eventually becoming the hottest remaining object on the Moon – you can see it as a white blob just up from the "o" in "Tycho" in Fig 1. Unfortunately, the experiment made back in 2007 was too poor resolution and wasn't really going anywhere, so further work was curtailed.

Roll on twelve years and what is really exciting about Darryl's work is the amazing improvement in image resolution that he is achieving. The potential uses for looking for changes on the Moon are immense. Whilst Thermal imaging of the Moon has been undertaken globally by missions such as Clementine in 1994, and the Diviner instrument on NASA's Lunar Reconnaissance Orbiter, these cover very small fields of view, fleetingly as the spacecraft orbit the Moon at 1 km/s. A system such that Darryl has set up could detect effects lasting many seconds, and cover very large regions of the nearside in one shot. Possible phenomena that could be detected (note the last two are speculative) could include:

The heat decay from impacts on the day and night side.

Ejecta from impacts on the night side, near the terminator, making it into sunlight and warming up, as was detected with the SMART-1 impact.

Heat generated from friction during localised shallow (violent) moonquakes – though these are rare as at around 5-6 per year, they are slightly more frequent during apogee and perigee and are sometimes associated with lobate scarps.

If gas were to be leaking, albeit perceptibly very, very, slowly (trickling) from the lunar surface, this might offer a means to cool the surface slightly below the temperature of the surrounds, during its release and hence could be detectable as transient cold spots.

So please keep an eye out for future article by Darryl in the TLO as this is very exciting work and he should be congratulated on these pioneering efforts in Earth-based lunar thermal IR imaging.

LTP reports: No LTP reports were received in October.

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

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

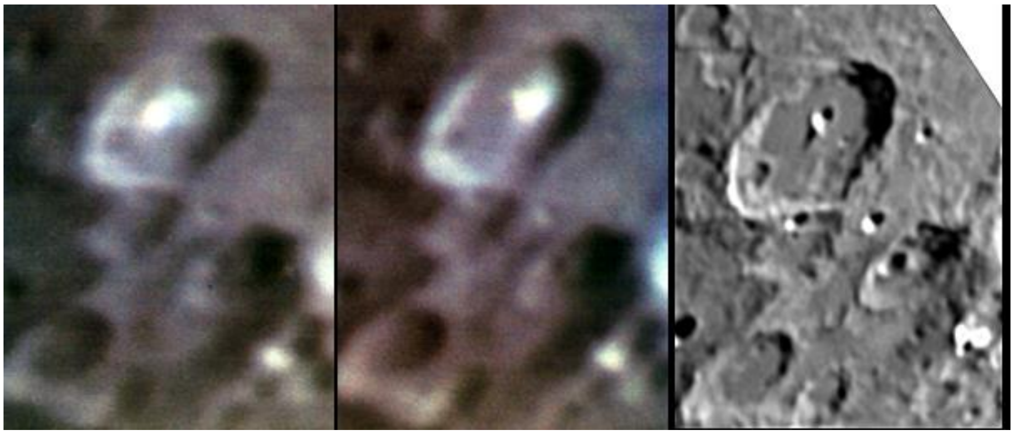


Figure 2. Pitiscus orientated with North towards the top. **(Left & Center)** 1981 Sep 05 photographs acquired sometime between 00:00 and 03:09 by Gary Slayton (From Sky and Telescope 1991 March, p266). **(Right)** Image captured by Walter Elias (AEA) taken on 2019 Oct 05 UT22:39).

Pitiscus: On 2019 Oct 05 UT 22:39 Walter Elias (AEA) imaged the Pitiscus region of the Moon under similar illumination (within ±0.5º) to the following Sky and Telescope report:

[REF 14] *Pitiscus 1981 Sep 05 UT ??:?? but assumed to be AM? which would make it 00:00-03:00UTC. Observed by Slayton (Fort Lauderdale, Florida, USA, 8" reflector, ASA 64EK7 f/170, Kodak Kodachrome) photographed a bright glow in the crater that appeared to move. Observer also reported seeing it visually noting that it looked gray with a tinge of red. For further information see p266 of Sky & Telescope (1991, March). Note that Cameron gives the date and UT at 1981 Sep 06 UT 01:00-01:30, or one day later. I will use this date and time from now on. The Cameron 2006 catalog ID=152 and weight=5. The ALPO/BAA weight=3.*

Walter's image shows nothing of the moving glow effect shown in the Slayton images (Fig 2). Such effects can be caused easily by internal reflections inside Barlow projection lenses, though the observer at the time reported seeing the effect visually? Anyway, in view of the time uncertainty in the original report, Walter's image can help us pin down the range of possible times for the Slayton photo more accurately.

Figure 3. Mons Piton: located on the top left of this image by Rik Hill (ALPO/BAA). Date and UT are as labelled in the image. Image orientated with north towards the top.

Mons Piton: On 2019 Oct 06 UT 01:30 Rik Hill (ALPO/BAA) imaged the Cassini to Caucasus area under both similar illumination and topocentric libration (within ±1.0º), and within similar illumination (within ±0.5º), respectively, to the following two reports:

[REF 15] *Mt Piton 2001 Sep 24 UT 19:25-19:55 Observed by Marie & Jeremy Cook (Frimley, Surrey, UK) described Mt as the brightest point on the terminator flaring seen on the southern end and red in color. Observers really thought it was normal (not an LTP) to be this bright and the flaring was spurious color. Worth checking out just in case, and also because it looks spectacular. ALPO/BAA weight=1.*

[REF 16] *On 1987 Jun 04 at UT02:26-03:26 D. Darling (Sun Praire, WI, USA, S=G and T=4) observed that Mons Piton was the brightest object on the Moon that he had ever noted before. Variations seen gave the mountain a "silvery" shine. The abnormal brightness was confirmed by another independent observer. The Cameron 2006 catalog ID=302 and the weight=5. the ALPO/BAA weight=2.*

So, Rik's image in Fig 3 does show Mons Piton as bright, but it is just the sunlit slopes emerging at sunrise, surrounded by a sea of shadow. However, the repeat illumination and topocentric libration tolerance is quite high so it is possible that it could get brighter than depicted in this image through natural reflectance with a small +/-1º change in these parameters?

Purbach: On 2019 Oct 06 UT 22:06 Victoria Gomez imaged this crater under similar illumination (within ±0.5º) to the following report:

[REF 17] *Purbach 1970 Apr 14 UT 12:00-14:00 Observed by Osawa (Awajt-Shima, Japan, 8" reflector, x288) "Photos in blue and orange taken. Ill-defined obscur. in blue photo in S. part of crater compared with orange. (neg. is so faint it is doubtful. Apollo 13 watch. Similar to Alter's findings in Alphonsus)." NASA catalog weight=2. NASA catalog ID #1250. ALPO/BAA weight=1.*

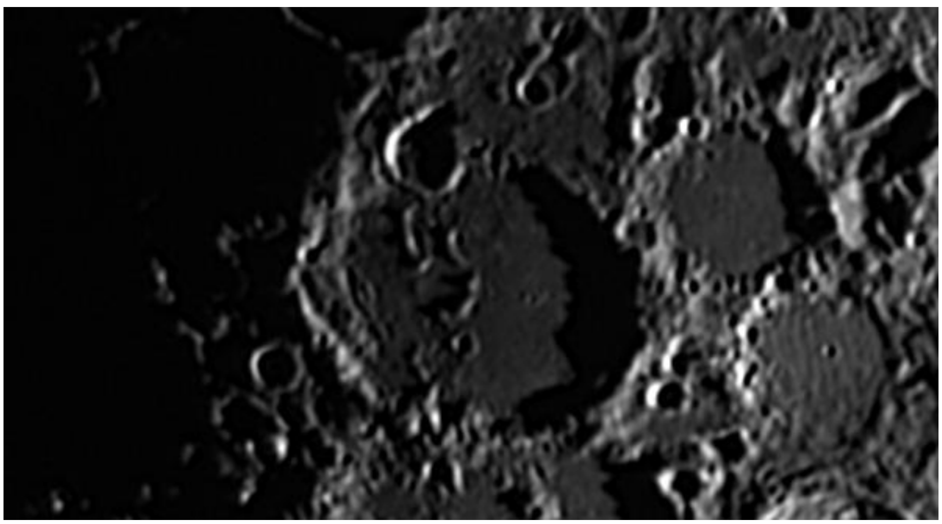


Figure 4. Purbach is located in the center of this monochrome image taken by Victoria Gomez (AEA) on 2019 Oct 06 UT 22:06. North is towards the top.

The 118 km diameter Purbach crater in Fig 4 shows no apparent sign of any obscuration on the southern part of the crater. However, the image is in monochrome.

Alphonsus: On 2019 Oct 06 UT 22:09 Aylen Borgatello (AEA) imaged and at 23:10-23:20 Alberto Anunziato (SLA) observed visually this crater under similar illumination (within ±0.5º) to the following two reports:

[REF 18] *Alphonsus 1967 Aug 13 UT 18:40-18:55 Observed by Horowitz (Haifa, Israel, 8" reflector?) "Glow or hazy patch seen while using filters. Brighter than background. Not seen after 2055 or next nite" NASA catalog weight=3. NASA catalog ID #1041. ALPOP/BAA weight=2.*

[REF 19] *On 1990 May 03 at UT 02:03 D. Darling (Sun Praire, WI, USA, seeing steady) observed a point of light inside Alphonsus just to the north of the central peak, along the "center ridge". It was seen again, half way between the central peak and the noth west rim - along the ridge. All other features were normal. The Cameron 2006 catalog ID=403 and the weight=3. The ALPO/BAA weight=3.*

Figure 5. Alphonsus is located in the image center. This was taken by AEA observer Aylen Borgatello on 2019 Oct 06 UT 22:09. The image is orientated with north towards the top.

Alberto was using a 105 mm Maksutov-Cassegrain (Meade EX 105) at a magnification of 154x. He could see quite clearly, with detail, the central peak, but none of the other events reported. Likewise, in the image (Fig 5) by Aylen, there is no sign of any glow or hazy patch (though the image is monochrome), nor any white spot north of the central peak. Although Alberto's observation was purely visual, it is important to remember that the original LTP observations were made visually too.

Copernicus: On 2019 Oct 08 at various times from 01:42-05:22 John Duchek (ALPO) imaged this crater and some at of these times they covered the following repeat illumination (within ±0.5º) events:

[REF 20] *On 2006 Jun 05 UT sometime during 21:00-22:00 G. Burt (SPA) made a drawing over a period of 30 minutes. Upon examining drawing, and comparing with photos made under similar illumination was struck by the abnormality of a small white blob in the north east corner of the shadowed floor. There should be no raised topography between the wall and the central peaks that could give rise to this. The making of the sketch overlapped with an earlier drawing made by Rony de Laet (Belgium) which did not show this blob. Subsequent attempts to find sketches/images at very similar illumination angles have failed to show the blob in the north east corner of the shadowed floor. ALPO/BAA weight=3.*

[REF 21] *On 1990 Apr 04 at UT 21:30-21:50 B. Le Franc (France?) reported observing a white flame effect in Copernicus crater (sketch made) - though Foley comments that the actual location was east of the crater. The Cameron 2006 catalog ID=398 and the weight=2. The ALPO/BAA weight=2.*

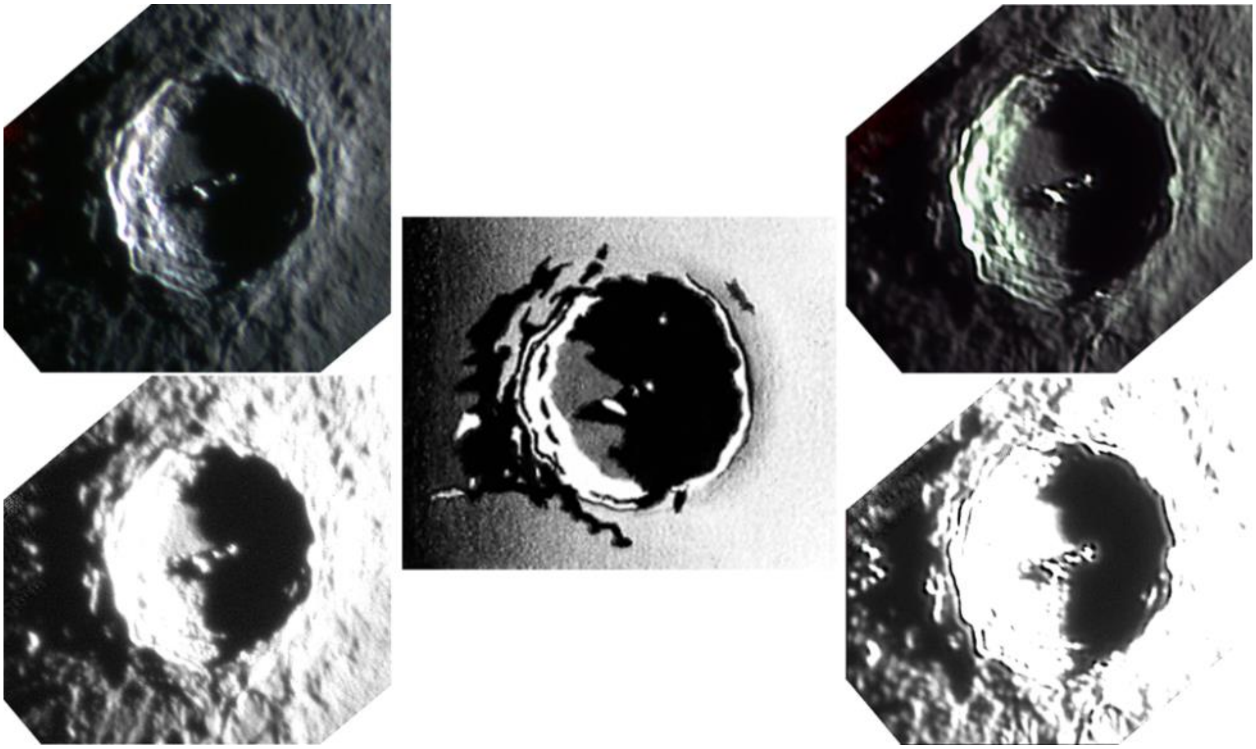


Figure 6. Copernicus orientated with north towards the top**. (Top Left)** Color image by John Duchek (ALPO) taken on 2019 Oct 08 UT 04:39 with color saturation increased. **(Bottom Left)** Same image by John Duchek (ALPO) but color removed and contrast stretched to bring out detail in the shadow. **(Top Right)** Color image by John Duchek (ALPO) taken on 2019 Oct 08 UT 05:20-05:22 with color saturation increased. **(Bottom Right)** Same image by John Duchek (ALPO) but color removed and contrast stretched to bring out detail in the shadow. **(Center)** A sketch by Geoff Burt (SPA) made on 2006 Jun 05 made in a 30-minute period sometime between 21:00 and 22:00.

John took a number of high-quality color images during the repeat illumination window. The two extremes of which are shown in Fig 6 for the Geoff Burt LTP repeat illumination window. For the Le Franc LTP, Fig 6 (Right) is the most similar in terms of illumination. Unfortunately, we appear to have no sketch, for the 1990 event, remaining in the ALPO/BAA archives - just the written description published in the BAA Lunar Section Circular.

Briggs: On 2011 Oct 11 UT Valerio Fontani (UAI) and Aldo Tonon (UAI) imaged this crater under similar illumination (selenographic colongitude in the range: 67.1ºto 68.0º) to the following Perter Grego report:

[REF 22] *On 2010 Apr 27 at UT 00:10-00:30 and 01:45-02:00 P. Grego (St Dennis, UK, 20 and 30cm reflectors) noticed a craterlet just to the east of Briggs and an E-W trending lineament or wrinkle ridge that did not show on NASA LAC charts. Further checks did not reveal it on Lunar Orbiter mosaics, or on very recent LROC images of the area. Possibly these are very low relief features that show only under very shallow illumination conditions. The ALPO/BAA weight=1 until we get confirmation at repeat illumination.*

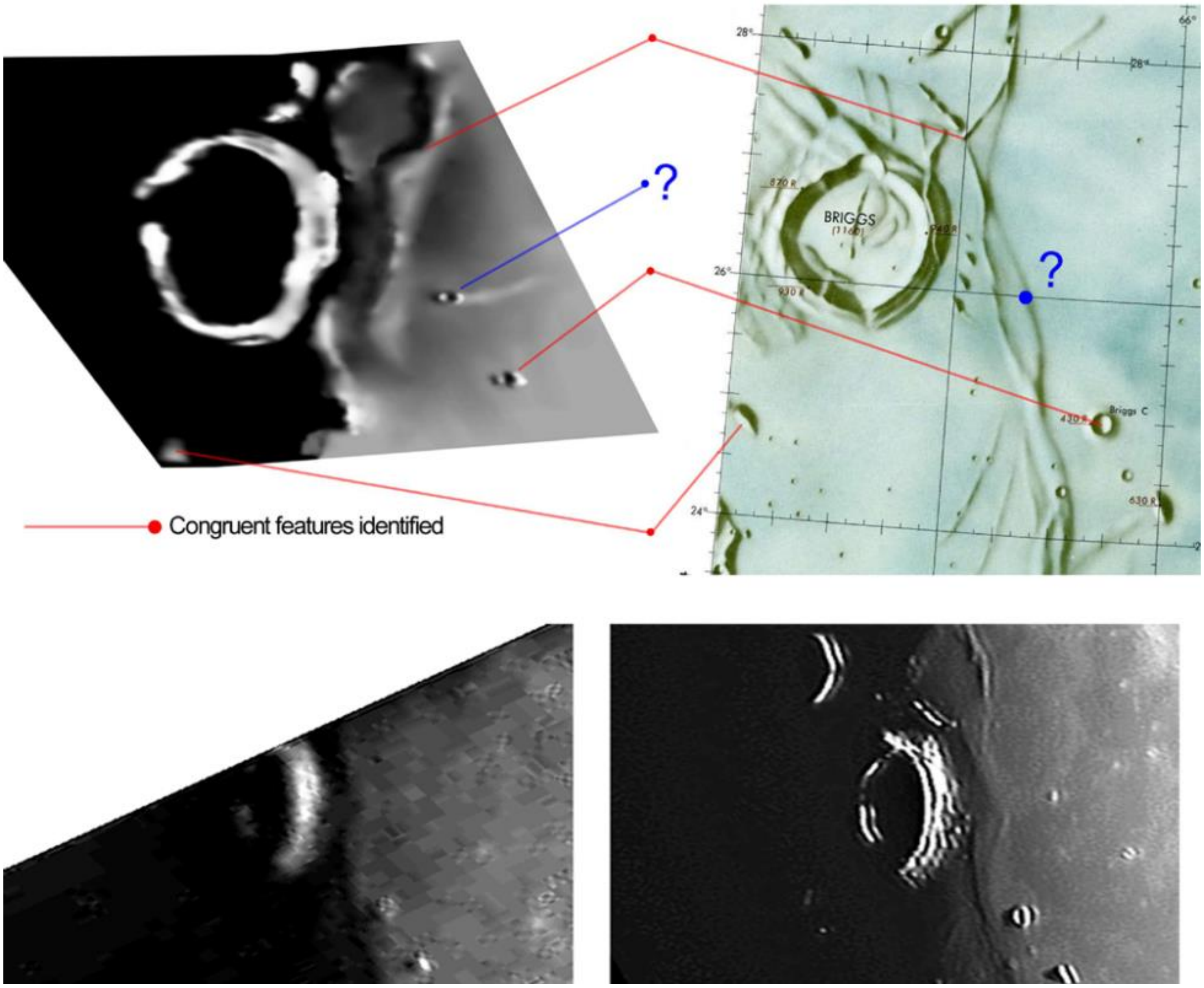


Figure 7. Briggs orientated with north to the top right. **(Top Left)** A sketch by Peter Grego based upon PDA sketches made on 2010 Apr 27 at UT 00:10-00:30 and 01:45-02:00. **(Top Right)** A portion of p23 from the Times Atlas of the Moon that Peter Grego had labelled. The red lines show features that are common to his sketch and the map. The blue refers to a crater that he saw but the map does not show. **(Bottom Left)** An image by Valerio Fontani (UAI) taken on 2019 Oct 11 at UT 20:11 – this has been subtracted from a much larger image and rescaled and re-orientated. **(Bottom Right)** An image by Aldo Tonon (UAI) taken on 2019 Oct 11 at UT 20:39. This too has been cut out from a larger image, rescaled and re-orientated.

Fig 7 is a good comparison between modern day images and Peter Grego's sketch. It is certainly clear on all of these where the wrinkle ridges lie to the east of Briggs. Briggs C is clearly visible on both the UAI images. It is not certain where the crater with a blue question marks (Fig 7 Top right) lies on the UAI images, unless it is either a piece of highland visible in Fig 5 (Bottom right) on the wrinkle ridge, or a mis-identification of the northern most of a couple of craterlets NE of Briggs C.

Aristarchus: On 2019 Oct 11 UT Thierry Speth (BAA) imaged the crater in red and blue filters under similar illumination and topocentric libration to the following two events:

[REF 23] *On 1975 Mar 25 at UT18:50-20:50 P.W. Foley (Kent, UK) observed blue/grey in Aristarchus. The ALPO/BAA weight=1.*

On 1983 Sep 20 at UT 05:08-06:13 Louderback (South Bend, WA, USA, 3" refractor, x150, seeing poor and chromatic aberration on the limb) detected "purple" in the vicinity of Aristarchus crater and this was strongest on the north and north west external rims, however there was no "violet glare" from inside the crater. However, the region of the central peak was very bright - though he could not detect the central peak. The brightness of the LTP was 4.5 and it should normally be 3 (nimbus area). Near the "big plain" it was 7. The chromatic aberration seen on the crater. There was also violet on the northern wall of Herodotus crater and the Cobra Head. It appeared dark blue in the blue filter"; the surrounds remained gray". Apparently on the 26th the "ring was still dark with faint violet - nearly normal". Cameron comments that the LTP was due to spurious color. The Cameron 2006 catalog ID=229 and the weight=3. The ALPO/BAA weight=2.

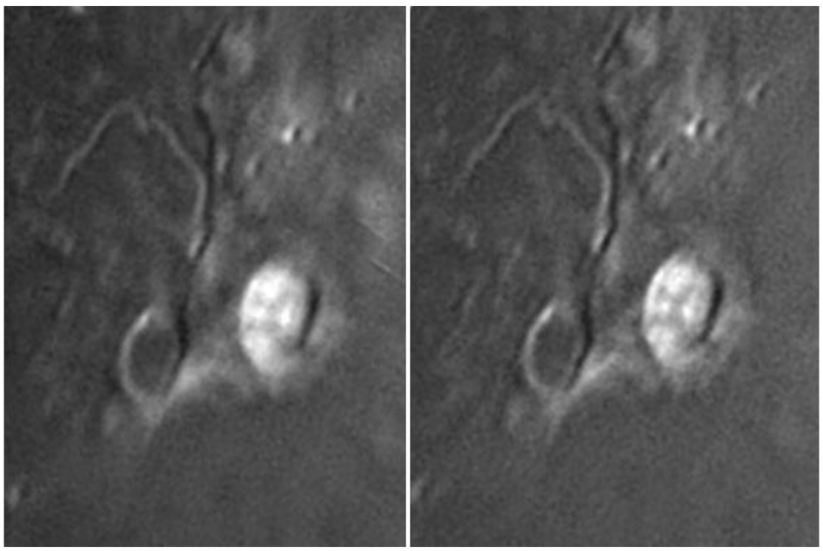


Figure 8. Aristarchus as imaged by Thierry Speth on 2019 Oct 11 and orientated with north towards the top. **(Left)** Blue filter image taken at 21:21UT. **(Right)** Red filter image taken at 21:22UT.

The images that Thierry took (Fig 8) give us a good indication of what Foley and Louderback should have seen in respective blue and red components of the spectrum – if they had used filters. Remember that blue should show up brighter in a blue filter image and red brighter in a red filter image. Of course, Rayleigh scattering complicates things as it loses some definition down the blue end of the spectrum by yielding more scattered light or diffuseness in normally dark areas as well as some image flare from bright areas.

Darwin: On 2019 Oct 12 UT 09:38 Maurice Collins imaged Darwin under similar illumination (within ±0.5º) to the following report:

[REF 24] *Darwin 1945 Oct 19 UT 23:23 - P. Moore (UK) saw 3 brilliant points of light on wall. 12" reflector used. NASA catalog ID #495, NASA weight=3. ALPO/BAA weight=3.*

Figure 9. Darwin, located in the center of the image, as captured by Maurice Collins on 2019 Oct 12 UT 09:38 and orientated with north towards the top. Image has been color normalised and had the color saturation increased to 40%.

In the image that Maurice took (Fig 9), it is uncertain which wall, east or west, on which Patrick Moore saw three brilliant points of light. But if it was on the south west wall (over exposed in this image), then maybe they refer the west rims of the three small craterlets here?

Aristarchus: On 2019 Oct 13 UT 18:56 Franco Taccogna (UAI) imaged the Full Moon when the crater Aristarchus was similar illumination (within ±0.5º) to the following report:

[REF 25] *Aristarchus 1976 Jan 16 UT 22:00-23:15 Observed by P.W. Foley (Wilmington, Kent, UK, seeing II) - Aristarchus was tremendously bright. No color seen. ALPO/BAA weight=1.*

Figure 10. The Full Moon as imaged by Franco Taccogna (UAI) on 2019 Oct 13 UT 18:56, and orientated with north towards the top right.

In terms of relative brightness, against an immediately adjacent dark mare background, one can say that visually Aristarchus looks stunningly bright, in Fig 10, compared to other features on the Moon. But in terms of absolute brightness, just by measuring digital number values in the image, we get in order of brightness: Censorinus (255), Proclus (252), bright spot near Hell (240), Aristarchus (236), Tycho (198) – so in an absolute sense Aristarchus is not the brightest feature on the Moon at this time.

Alphonsus: On 2019 Oct 18 UT 22:48 Ivan Walton (BAA) imaged this are under similar illumination (within ±0.5º) to the following report:

[REF 26] *Alphonsus 2002 Sep 27 UT 00:00-02:15 Observed by Clive Brook (Plymouth, UK) "Central peak was bright 00:00 UT but had faded by at least 2 deg on the Schroter scale - no color seen. Observer continued observing until 02:15 UT but central peak had dimmed considerably by then". ALPO/BAA weight=2.*

Figure 11. Alphonsus as located at the center of the image and orientated with north towards the top. Image taken by Ivan Walton (BAA) on 2019 Oct 22:48.

Although Ivan's image covers a large area of the Moon, you can at least just see the location of the central peak in Alphonsus in Fig 11, as well as three of the dark spots on the floor.

Grimaldi: On 2019 Oct 25 UT 10:30-10:50 Jay Albert (ALPO) observed visually this area under similar illumination (within ±0.5º) to the following report:

[REF 27] *Grimaldi 1938 Mar 28 UT 09:30 Observer: Firsoff (Glastonbury, UK - 6" reflector) - Slight greenish color - {Note the UT given in the NASA catalog is 09:30 which is in daylight here in the UK - possibly the catalog is wrong, else the observer was observing in daylight, but worth checking out just in case}. NASA catalog ID No. #433 and NASA weight=4. ALPO/BAA weight = 3.*

Jay was using just Celestron 7-21x50mm tripod mounted binoculars, but at a magnification of x21. He saw, through these binoculars, a strong green fringe along the lit edge of the crescent. This gave the impression of the dark floor of Grimaldi a having slight greenish tint, in contrast to the bright sunlit west limb of the Moon. He goes onto say that in his view that the green color was due to the optics of the binoculars and nothing to do with the Moon. We have covered this LTP before in the 2018 Feb edition of this newsletter.

Snellius: On 2019 Oct 31 UT 22:35 Alan Trumper (AEA) imaged this crater just 7 min outside similar repeat illumination and topocentric libration (within ±1.0º) to the following report:

[REF 28] *On 1978 Dec 01 at 17:00UT Christie (England?, x60 magnification) found Snellius to be indistinct (could not locate). Cameron 2006 catalog ID=23 and weight=1. ALPO/BAA weight=1.*

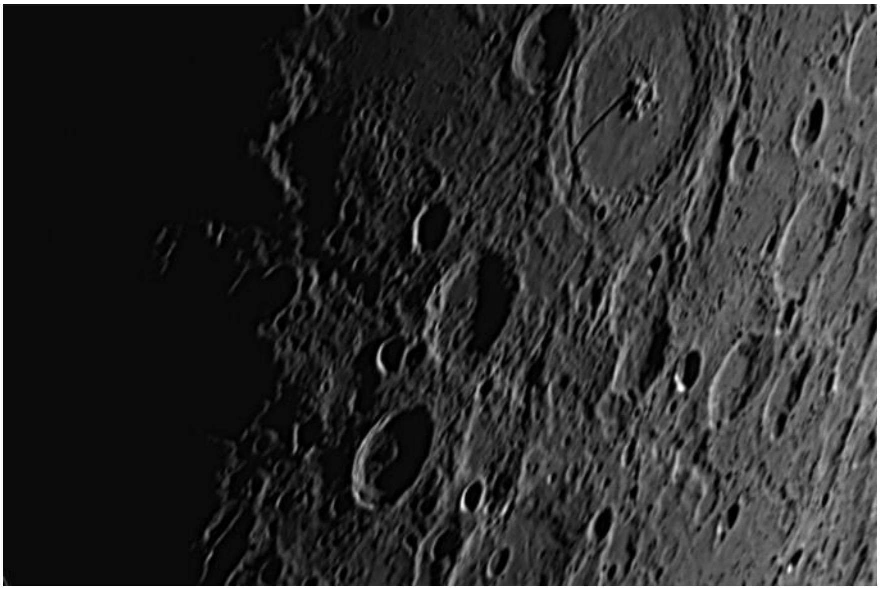


Figure 12. Snellius as located at the center of the image and orientated with north towards the top. Image taken by Alan Trumper (AEA) on 2019 Oct 31 UT 22:35.

[REF 29] *Mare Crisium 1972 Mar 18 UT 19:06-21:00 Observed by Prvost and Dorchain (Belgium, 3.5" reflector, 168x and 336x) "at 1906h Pruvust rep'ted 2 pts. moving from Auzout to Prom. Olivium. Minutes later, Dorchain saw a new pt. Others saw nothing unusual fr. 1912-2100h (Fitton, Ash, Peters, Watkins, et al in England - but this was later than the event)" NASA catalog weight=2. NASA catalog ID #1325. ALPO/BAA weight=1.*

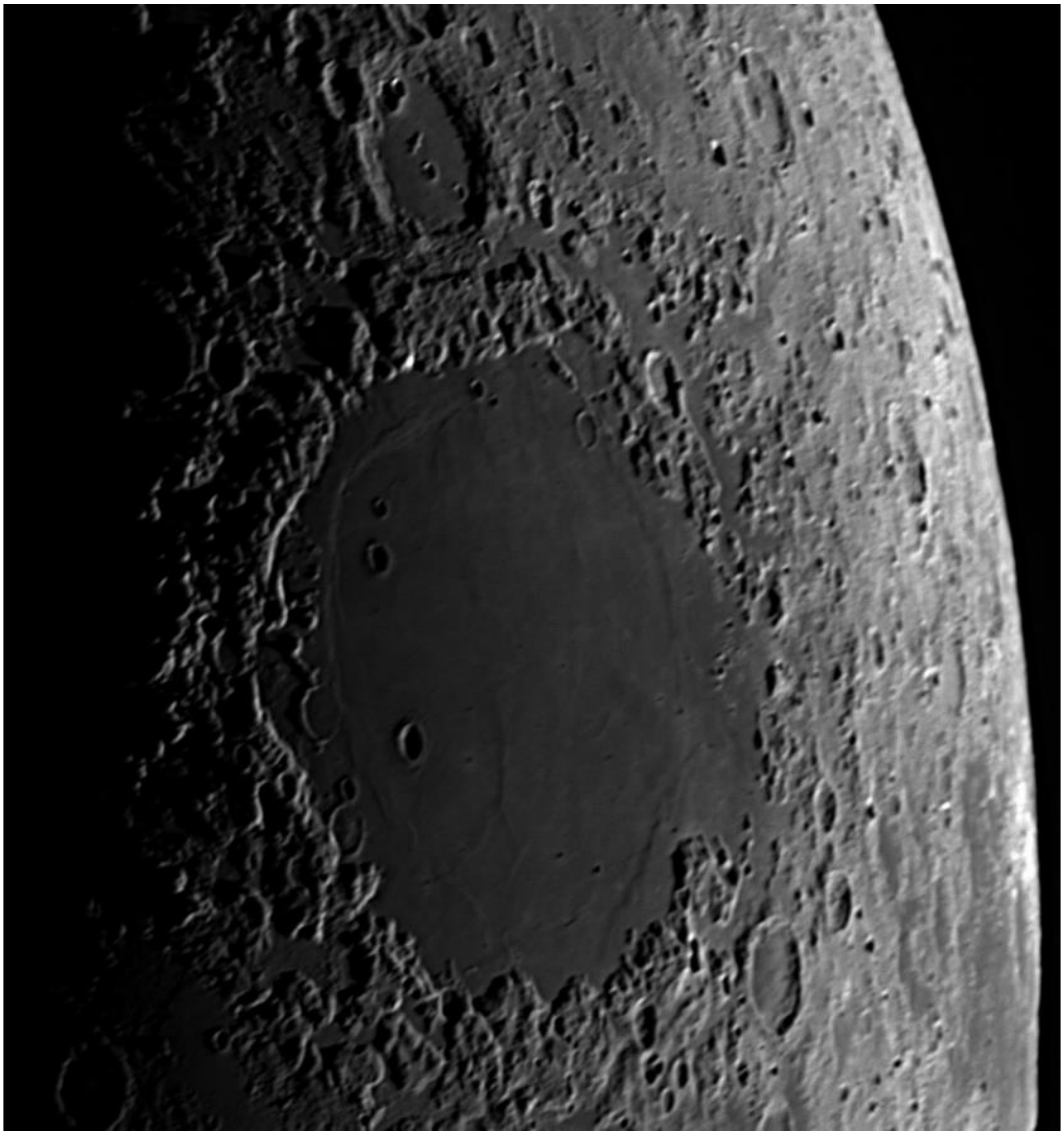


Figure 13. Mare Crisium as imaged by Facundo Gramer (AEA) on 2019 Oct 31 UT 23:31 and orientated with north towards the top.

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 LTP, firstly read the LTP 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 LTP alerts can be accessed on https://twitter.com/lunarnaut .

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

SUBMISSION THROUGH THE ALPO IMAGE ARCHIVE

ALPO's archives go back many years and preserve the many observations and reports made by amateur astronomers. ALPO's galleries allow you to see on-line the thumbnail images of the submitted pictures/observations, as well as full size versions. It now is as simple as sending an email to include your images in the archives. Simply attach the image to an email addressed to

lunar@alpo-astronomy.org (lunar images).

It is helpful if the filenames follow the naming convention :

FEATURE-NAME_YYYY-MM-DD-HHMM.ext

YYYY {0..9} Year

MM {0..9} Month

DD {0..9} Day

HH {0..9} Hour (UT)

MM {0..9} Minute (UT)

.ext (file type extension)

(NO spaces or special characters other than "_" or "-". Spaces within a feature name should be replaced by "-".)

As an example the following file name would be a valid filename:

Sinus-Iridum_2018-04-25-0916.jpg
(Feature Sinus Iridum, Year 2018, Month April, Day 25, UT Time 09 hr16 min)

Additional information requested for lunar images (next page) should, if possible, be included on the image. Alternatively, include the information in the submittal e-mail, and/or in the file name (in which case, the coordinator will superimpose it on the image before archiving). As always, additional commentary is always welcome and should be included in the submittal email, or attached as a separate file.

If the filename does not conform to the standard, the staff member who uploads the image into the data base will make the changes prior to uploading the image(s). However, use of the recommended format, reduces the effort to post the images significantly. Observers who submit digital versions of drawings should scan their images at a resolution of 72 dpi and save the file as a 8 1/2"“x 11” or A4 sized picture.

Finally a word to the type and size of the submitted images. It is recommended that the image type of the file submitted be jpg. Other file types (such as png, bmp or tif) may be submitted, but may be converted to jpg at the discretion of the coordinator. Use the minimum file size that retains image detail (use jpg quality settings. Most single frame images are adequately represented at 200-300 kB). However, images intended for photometric analysis should be submitted as tif or bmp files to avoid lossy compression.

Images may still be submitted directly to the coordinators (as described on the next page). However, since all images submitted through the on-line gallery will be automatically forwarded to the coordinators, it has the advantage of not changing if coordinators change.

When submitting observations to the A.L.P.O. Lunar Section

In addition to information specifically related to the observing program being addressed, the following data should be included:

Name and location of observer
Name of feature
Date and time (UT) of observation (use month name or specify mm-dd-yyyy-hhmm or yyyy-mm-dd-hhmm)
Filter (if used)
Size and type of telescope used Magnification (for sketches)
Medium employed (for photos and electronic images)
Orientation of image: (North/South - East/West)
Seeing: 0 to 10 (0-Worst 10-Best)
Transparency: 1 to 6

Resolution appropriate to the image detail is preferred-it is not necessary to reduce the size of images. *Additional commentary accompanying images is always welcome.* **Items in bold are required. Submissions lacking this basic information will be discarded.**

Digitally submitted images should be sent to:
David Teske – david.teske@alpo-astronomy.org
Jerry Hubbell –jerry.hubbell@alpo-astronomy.org
Wayne Bailey—wayne.bailey@alpo-astronomy.org

Hard copy submissions should be mailed to David Teske at the address on page one.

CALL FOR OBSERVATIONS: FOCUS ON: Plato & Theophilus

Focus on is a bi-monthly series of articles, which includes observations received for a specific feature or class of features. The subject for the **January 2020** edition will be the Plato and Theophilus regions. Observations at all phases and of all kinds (electronic or film based images, drawings, etc.) are welcomed and invited. Keep in mind that observations do not have to be recent ones, so search your files and/or add these features to your observing list and send your favorites to (both):
Jerry Hubbell –jerry.hubbell@alpo-astronomy.org
David Teske – david.teske@alpo-astronomy.org

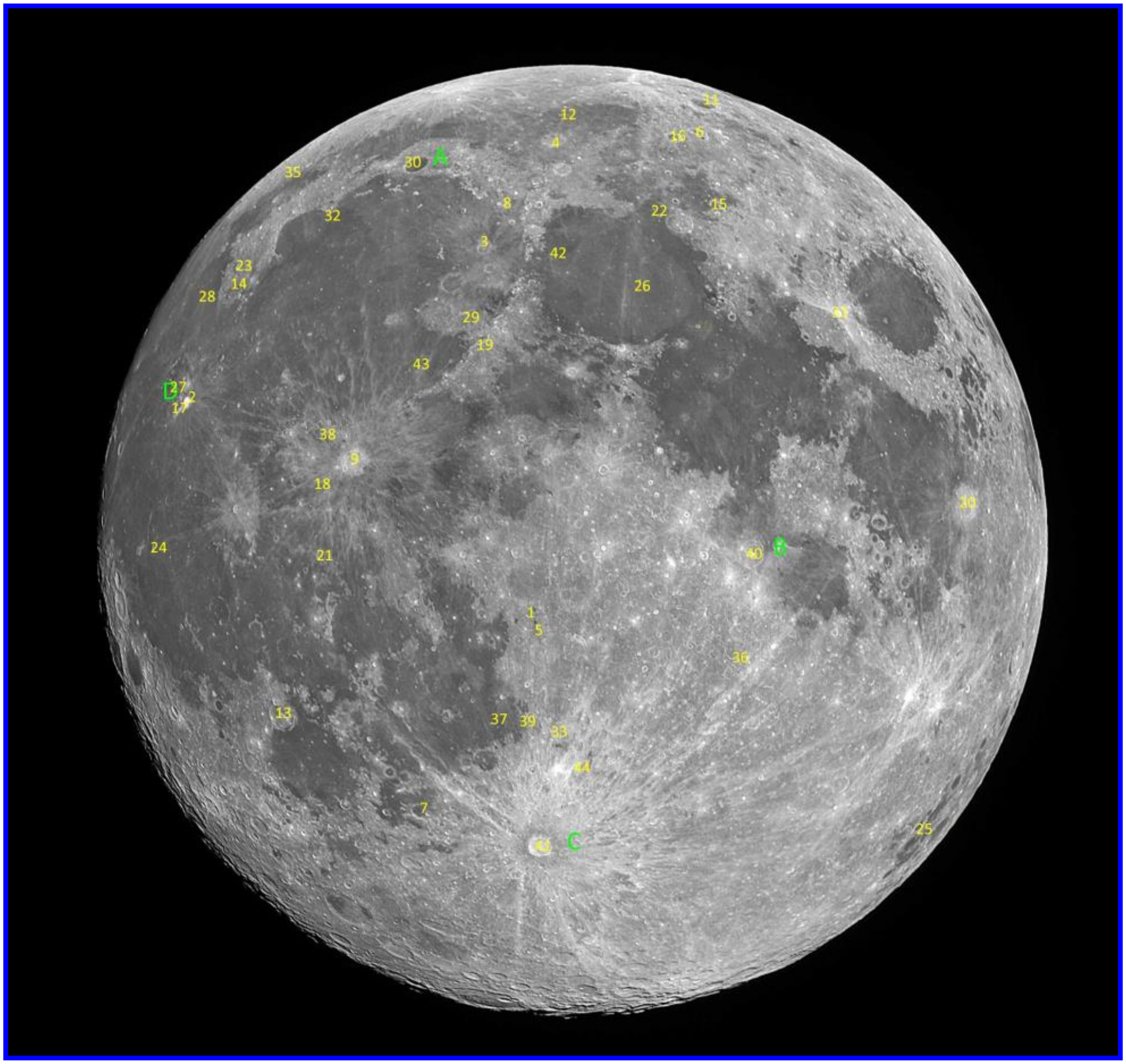
Deadline for inclusion in the Plato and Theophilus region article is December. 20, 2019

FUTURE FOCUS ON ARTICLES:

In order to provide more lead time for contributors the following future targets have been selected: The next series of three will concentrate on subjects of the Selected Areas Program.

Subject	TLO Issue	Deadline
Plato & Theophilus	January 2020	December 20, 2019
Tycho & Herodotus	March 2020	February 20, 2020

Key to Images In This Issue



1. Alphonsus
2. Aristarchus
3. Aristillus
4. Aristoteles
5. Arzachel
6. Atlas
7. Capuanus
8. Cassini
9. Copernicus
10. Dawes
11. Endymion
12. Galle
13. Gassendi
14. Gruithuisen
15. Hall
16. Hercules
17. Herodotus
18. Hortensius
19. Huxley
20. Langrenus
21. Lansberg
22. Luther
23. Mairan
24. Marius
25. Mare Australe
26. Mare Serenity
27. Mons Herodotus
28. Mons Rumker
29. Palus Putredinus
30. Plato
31. Proclus
32. Promontorium Leplace
33. Purbach
34. Ptolemaeus
35. Pythagoras
36. Rupes Altai
37. Rupes Recta
38. T. Mayer
39. Thebit
40. Theophilus
41. Tycho
42. Valentine Dome
43. Wallace
44. Werner

Upcoming Focus-On targets:

A. Plato
B. Theophilus
C. Tycho
D. Herodotus