The Lunar Observer

A publication of the Lunar Section of ALPO

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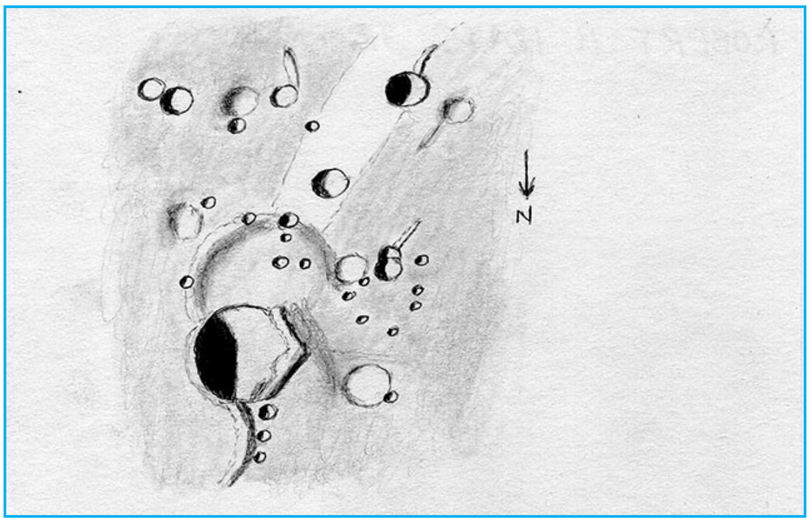
Recent back issues: http://moon.scopesandscapes.com/tlo_back.html

Feature of the Month—September 2019

Gemma Frisius



Sketch by Robert H. Hayes, Jr—Worth, Illinois, USA
June 11, 2019 0226-0306; 0328-0340 UT, 15 cm reflector, 170 x
Seeing 8-9/10, transparency 6/6

I observed this crater and vicinity on the evening of June 10/11, 2019. This area is located north of Maurolycus and just west of Gemma Frisius itself. Gemma Frisius D (Gem Fri D) is another example of a non-circular crater. Its eastern side is quite round, but its western side has sharp angles. There are straight edges coming to a point on the west end. Its interior shadow also looked odd. The shape may have resulted from slumped walls. Gem Fri D has obliterated the north end of a larger but vague old ring. There is a great variety of craters nearby. Gemma Frisius F is the middling crater just southwest of the old ring.

A clump of four smaller craters straddles this old rim. Three more small pits and a fuzzy squarish crater are east of this group. Gemma Frisius Z is the largest crisp feature southwest of D. The Lunar Quadrant map shows it as single, but I saw it as a double crater. A vague saucer is just east of Z, and a larger, similar saucer is to its north. There is a generous sprinkling of tiny pits in this area. A line of three more small craters extends northward from Gem Fri D. These are near a low curved ridge which may be part of the ghost ring Gemma Frisius G. The large, deep crater southwest of Gem Fri F is Kaiser C, and a low squarish ring is just to its west. Gemma Frisius EA is well to the southeast of Gem Fri D, and is very much like Gem Fri F. A small, shallow crater is just east of Gem Fri EA, and two fuzzy craters are to its west, toward Kaiser C. Two small, crisper pits are to their north. Short ridges extend from some craters, notably Kaiser C and Gem Fri Z. A strip slightly brighter than the surrounding area takes in Gem Fri F and Kaiser C.

Lunar Calendar September 2019

2019	U.T.	EVENT
September 06	03:10	First Quarter
08		Greatest Southern declination, -22.5^{o}
13	1400	Moon Apogee, 406,377 km, diameter 29’ 24”
14	0433	Full Moon
22	0241	Last Quarter
22	0900	Moon 2.0^{o} south of M35
23		Greatest North declination +22.7^{o}
24	2200	Moon 0.4^{o}N of M44
28	0200	Moon Perigee, 357,803 km, diameter 33’ 24” Large Tides
28	1826	New Moon, Lunation 1197

Favorable Librations

September 7	Hecataeus B Crater
September 10	Hubble Crater
September 26	Baade Crater
September 27	Hausen Crater

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 pages 20-21 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

Acting Coordinator – David Teske - david.teske@alpo-astronomy.org
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Assistant Coordinator – Jerry Hubbell – jerry.hubbell@alpo-astronomy.org
Assistant Coordinator-Wayne Bailey– wayne.bailey@alpo-astronomy.org
Website: http://moon.scopesandscapes.com/

OBSERVATIONS RECEIVED

Alberto Anunziato - Oro Verde, Argentina. Digital image and article about Alphonsus.

Fransico Alsina Cardinali - Oro Verde, Argentina. Digital images of Burg and Theophilus.

Jairo Chavez - Popayán, Columbia. Digital images of Copernicus (2), Full Moon (2), Plato, Tycho (2), Clavius, Werner, Waxing Gibbous Moon and Waning Gibbous Moon.

Darryl Wilson- Marshall, Virginia, USA. Digital thermal and comparison images of the Moon (6), article about lunar thermal imaging.

Walter Ricardo Elias -AEA - Oro Verde, Entre Rios, Argentina. Digital images of Prolus (6), Tycho, Plato (3), Macrobius, Mare Tranquillitatis, maxing crescent Moon, Copernicus, Conon, Manilius (2).

Howard Eskildsen - Ocala, Florida, USA. Digital image and article about Herodotus Omega Dome, digital image and article about Rimae Ritter and Ritter 1 Dome, images of the Menalaus domes, Murchison domes, Aristillus to Putridinus and lunar domes near Aristillus.

Desiré Godoy —Oro Verde, Argentina. Digital image of Aristarchus.

Robert Hays Jr. -Worth, Illinois, USA. Drawing of Gemma Frisius

Richard Hill – Tucson Arizona, USA. Digital images and article about Taurus Littrow, Mare Smythii, and North of Aristarchus. Digital images of Alphonsus (11), Aristarchus (12), Catena Davy.

Jerry Hubbell - Wilderness, Virginia, USA. Digital image of the 21 day old Moon, Focus On article Alphonsus and Arsistarchus..

David Teske—Louisville, Mississippi, USA. Digital image and article about Grimaldi, digital image of Aristarchus..

Alan Trumper– AEA - Oro Verde, Entre Rios, Argentina Digital images of Censorinus and Mare Nectaris.

Román García Verdier -Paraná, Argentina. Digital image of Aristarchus.

Many thanks for all these observations, images, and drawings.

Focus On: Alphonsus, Aristarchus & Herodotus

Jerry Hubbell

Assistant Coordinator, Lunar Topographical Studies

This month we start on a new series of articles based on the craters in the Lunar Topographical Studies Selected Areas Program (SAP). This is a visual observing program that most beginners can easily start out using a small refractor or Newtonian reflector. This observing program is designed to focus attention on areas of the moon that have shown unusual albedo changes during the lunation period. As stated on the main SAP webpage:

> *"While there is a definite requirement to know how various lunar features change their normal appearance throughout a lunation in response to variations in phase angle, even more intriguing are those lunar features that behave in an unusual, sometimes unpredictable, and non-repeating manner as solar illumination changes. The A.L.P.O. Lunar Selected Areas Program (SAP) is chiefly concerned with systematically monitoring regular and cyclical long-term variations during many lunations of specifically designated, or "selected", areas on the Moon. In general, the SAP is designed to intensively study and document for each of these features the normal albedo changes in response to conditions of varying solar illumination."*

The SAP is a great way to get familiar with some of the main features of the Moon and enjoy visually roaming over the landscape to see every tiny detail. You will find all the information needed to start this observing program at the link above.

This series of articles over the next 6 months will cover the areas defined in the program and will be discussing an additional way you can observe and monitor these areas using your high-resolution lunar images or other images you may find online. Using the Lunar Terminator Visualization Tool (LTVT) you can do various measurements of these craters and perhaps provide more insight into the "regular and cyclical long-term variations" that may occur in these areas. The LTVT allows you to not only measure the size of features, but also systematically measure the size of the various peaks and hills on the moon through shadow measurements. Some of the changes in these areas involve the shifting shadows and by measuring specific locations over the long-term, the apparent shift in the measured heights over time might give us additional data. Using the SAP crater drawing templates and the Lunar Aeronautical Charts for each crater, I will be identifying specific shadows to measure. I am welcome to any suggestions you may have in this regard.

The craters in the SAP include: Alphonsus – 71 miles (118 km), Aristarchus – 24 miles (40 km), Atlas – 53 miles (88 km), Copernicus – 56 miles (93 km), Herodotus – 21 miles (35 km), Plato – 61 miles (101 km), Theophilus – 61 miles (101 km), and Tycho – 52 miles (86 km). This month we start with the craters Alphonsus, Aristarchus & Herodotus. Figures 1 and 3 show the crater drawing outlines used in the SAP for Alphonsus, Aristarchus & Herodotus, and Figures 2 and 4 show the Lunar Aeronautical Chart view of these craters. Note that the SAP drawings are depicted rotated 180° (north up, east right) as compared to the crater drawing outline chart (SAP form) available on the website to more easily compare to the LAC charts.

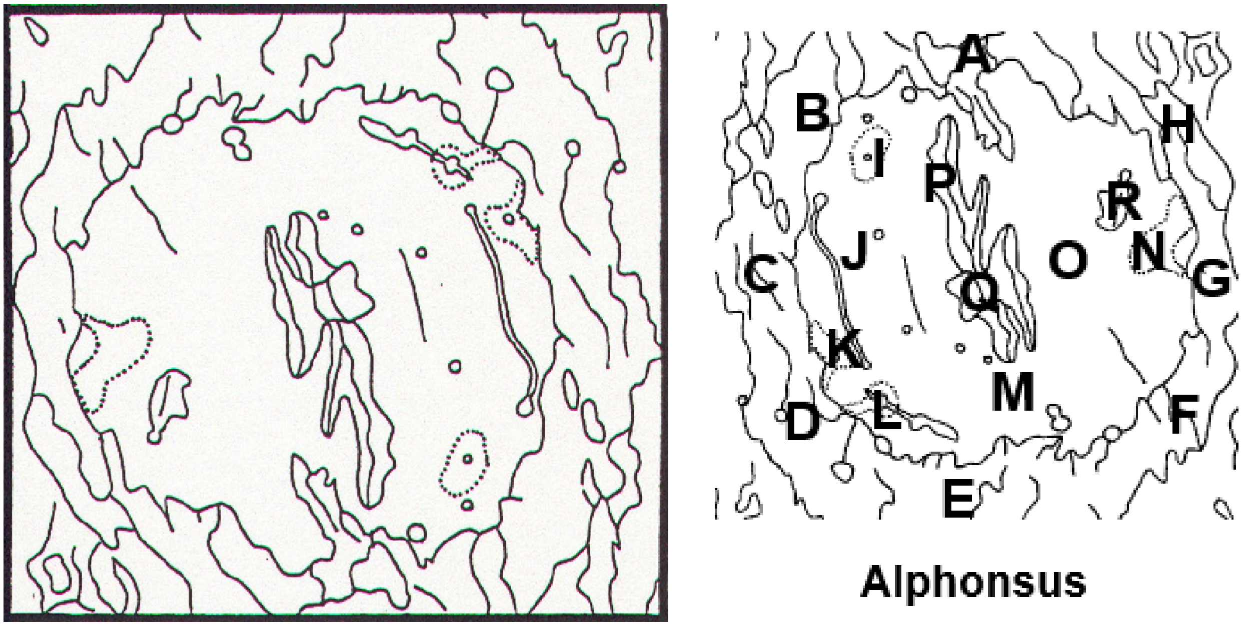

***Figure 1**. a) Outline drawing of Alphonsus (north-up, east-right). b) Albedo Points for Alphonsus (north-down, east-left)*

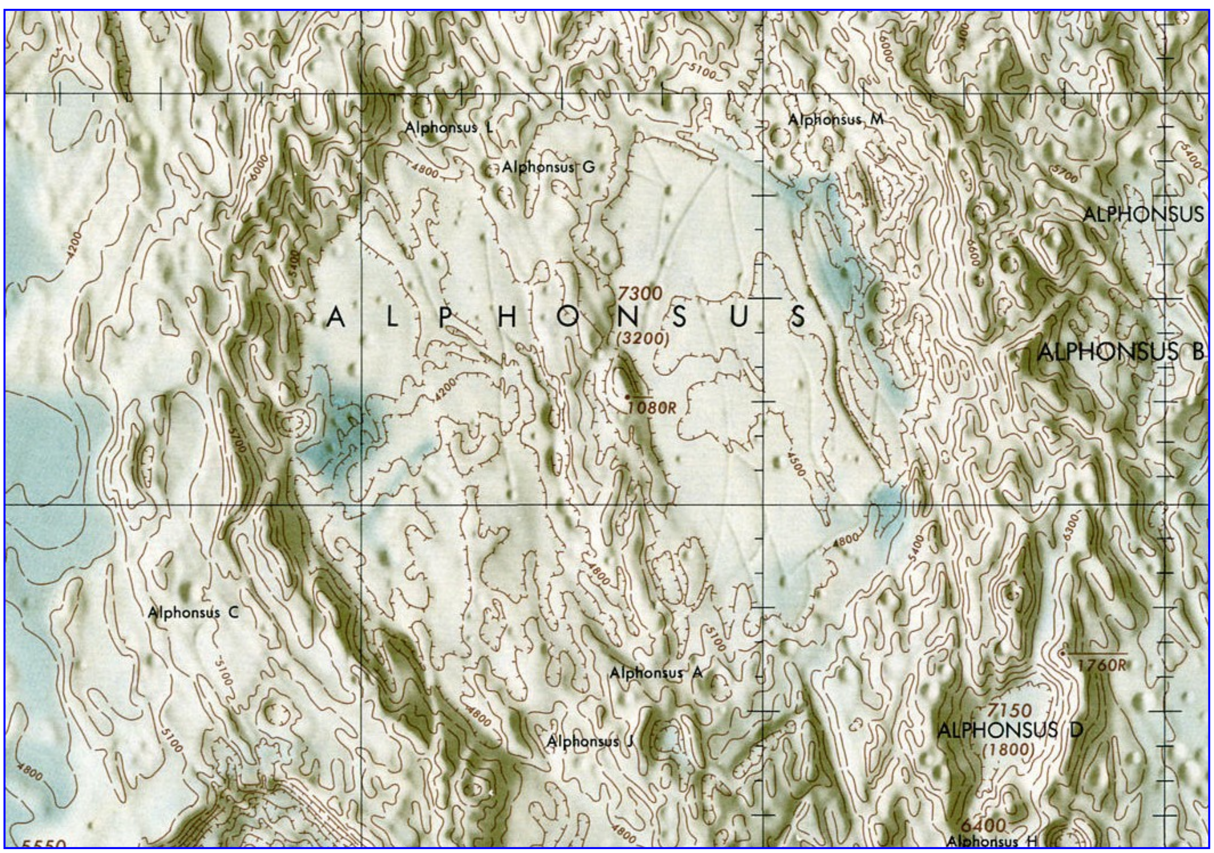

***Figure 2**. LAC77 chart of Alphonsus. (north-up, east-right)*

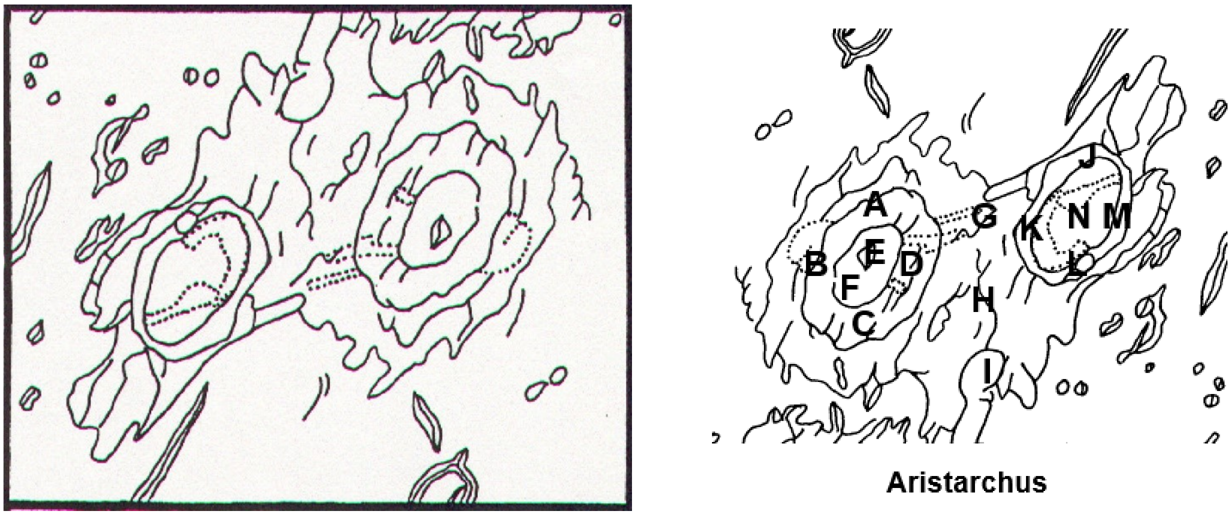

Figure 3. *a) Outline drawing of Aristarchus and Herodotus (north-up, east-right). b) Albedo points for Aristarchus and Herodotus (north-down, east-left).*

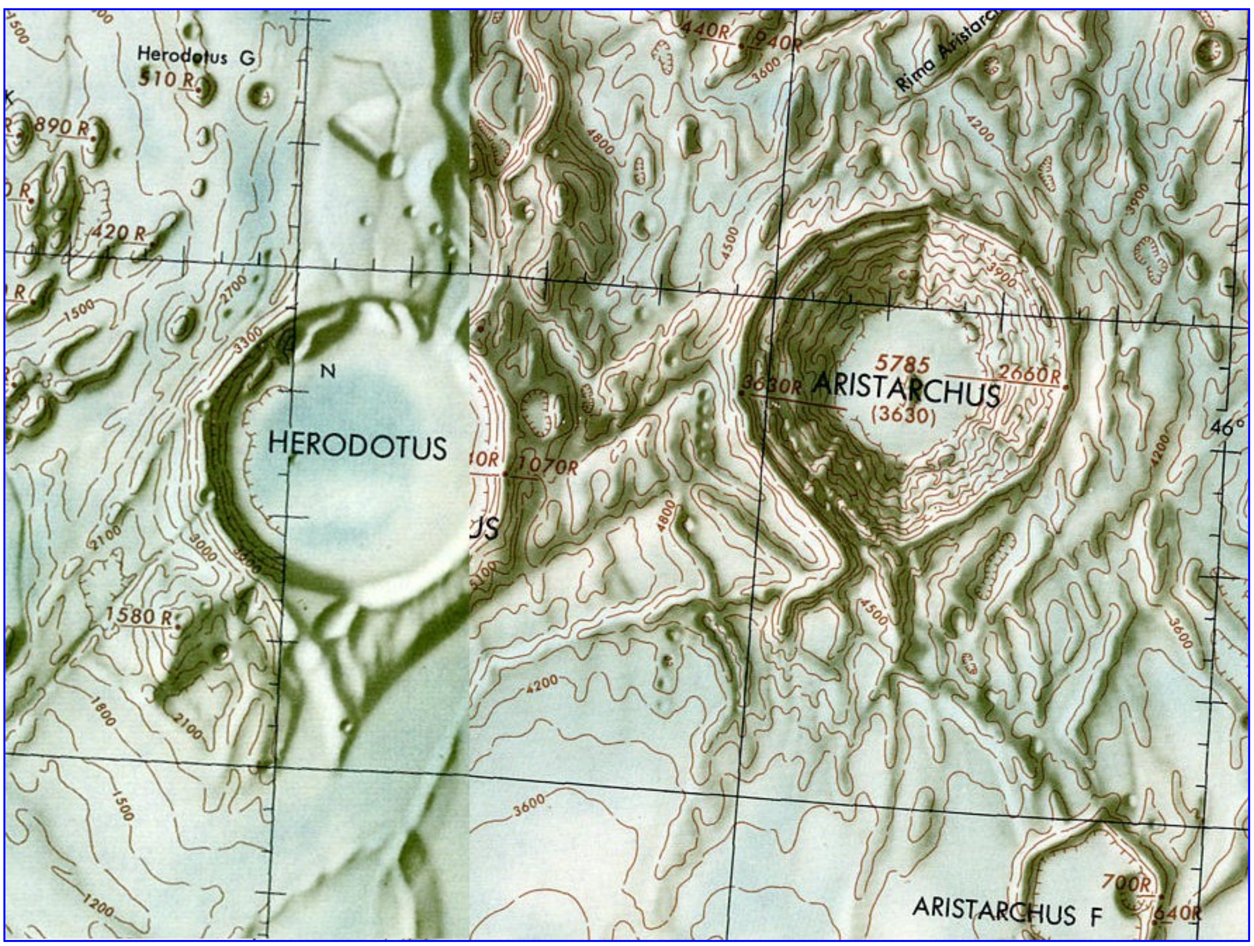

Figure 4. *LAC38 and LAC39 chart (combined) of Aristarchus and Herodotus*

Rik Hill has provided some great examples of images of these craters and you can see the image of Alphonsus (Figure 5) and Aristarchus & Herodotus (Figure 8.) I provided one of my early images of Alphonsus taken in 2011. Figures 7 and 9 show the LTVT processed images showing the measurements of the diameter, longitude and latitude of each crater.

Figure 5. *Ptolemaeus, Alphonsus, and Arzachel Region. Rik Hill, Tucson, Arizona, USA, 09 May 2014, 0350 UT. Colongitude, 28.1°, TEC 8-inch f/20 Mak-Cas, SKYRIS 445m CCD Camera + Red filter. Seeing, 4/5.*

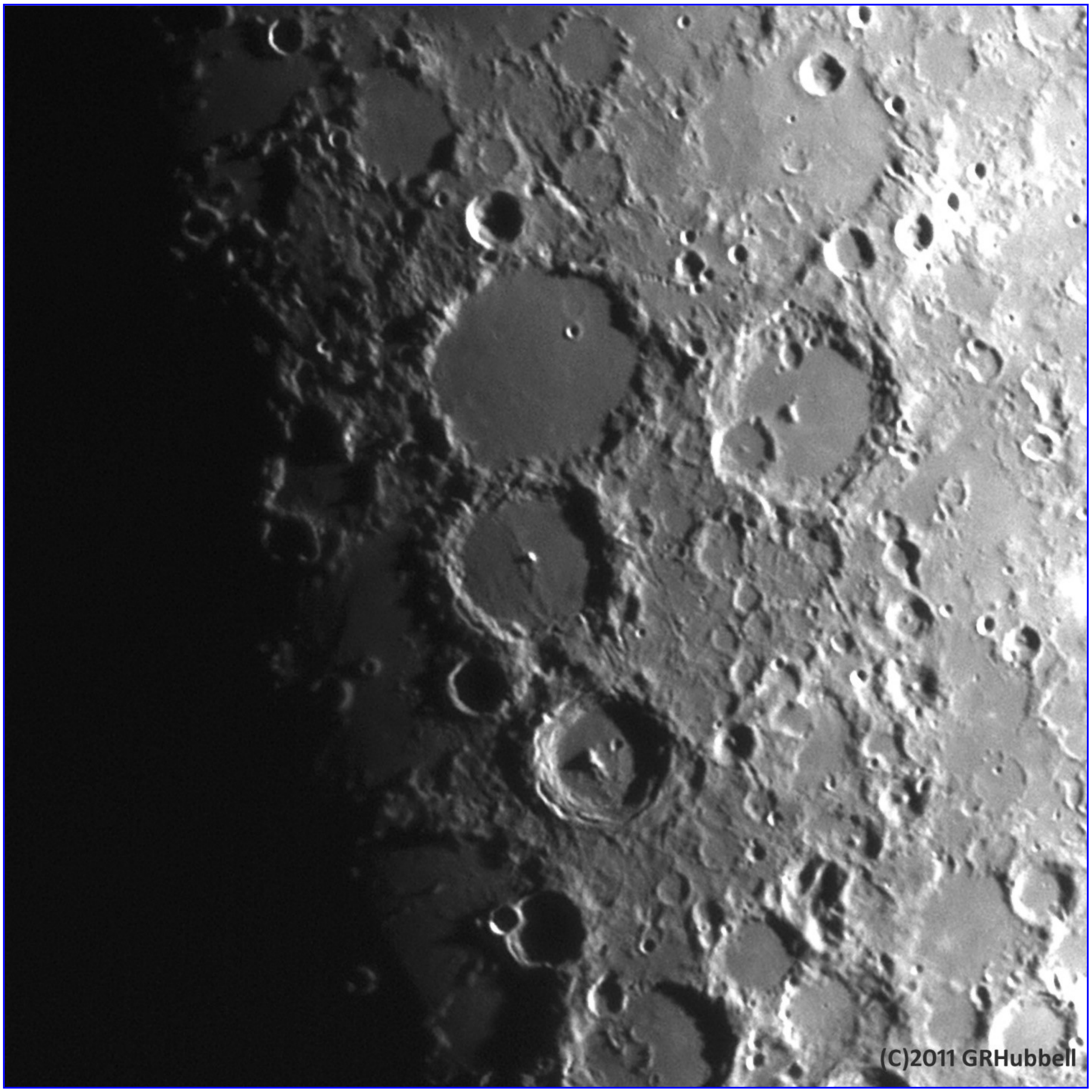

Figure 6. *Ptolemaeus, Alphonsus, and Arzachel Region. Jerry Hubbell, Locust Grove, Virginia, 13 March 2011, 0217 UT. Colongitude, 11.4°, SkyWatcher 12-cm f/7.5 APO refractor, ATIK 314e CCD Camera + 2x Barlow. Visibility, 4/5 Transparency, 3/5.*

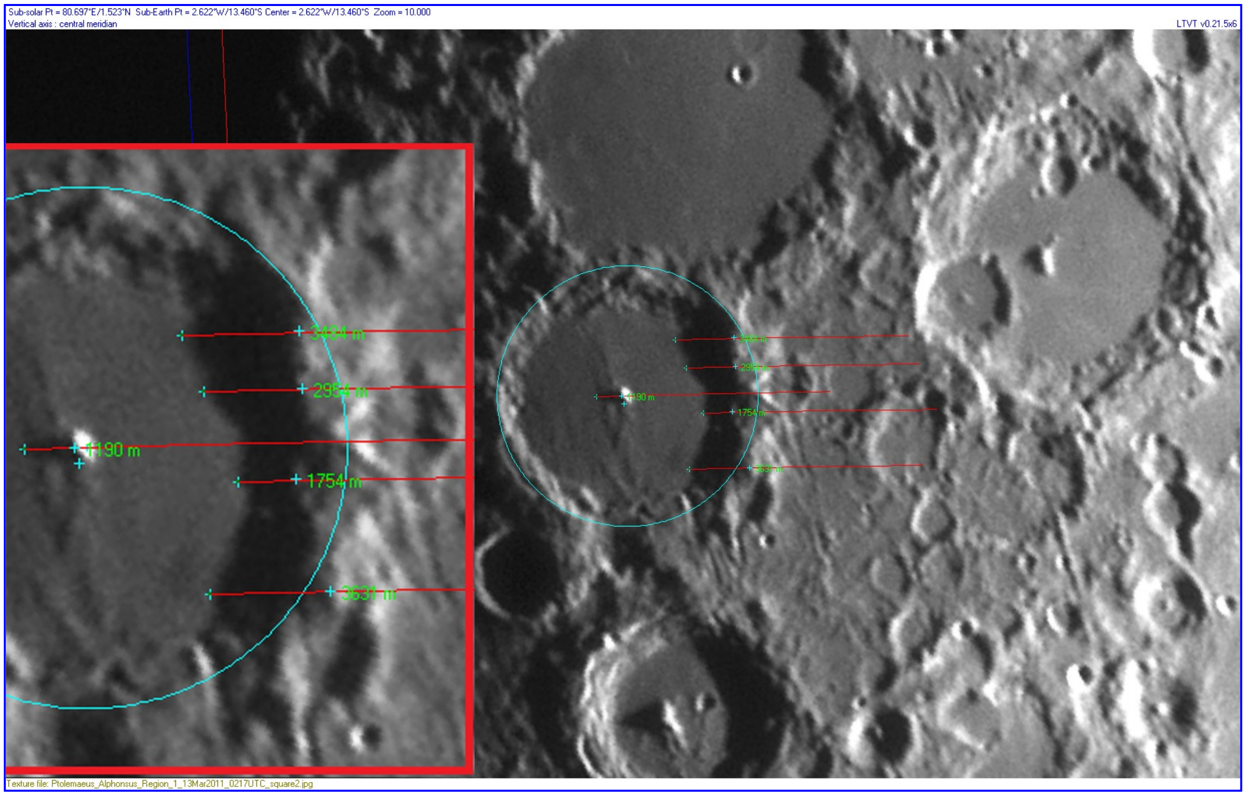

Figure 7. *Alphonsus LTVT Measurements. Jerry Hubbell, Locust Grove, Virginia, 13 March 2011, 0217 UT. Colongitude, 11.4°, SkyWatcher 12-cm f/7.5 APO refractor, ATIK 314e CCD Camera + 2x Barlow. Visibility, 4/5 Transparency, 3/5.*

Parameter	**Measured Value**	**Chart/Catalog Value**	**Diff**
Selenographic Longitude	W02°34’	W02°51’	- 0°17’
Selenographic Latitude	S13°20’	S13°44’	- 0°24’
Crater Diameter	121 km (75.2 miles)	118 km (73.3 miles)	+ 2.5%
Central Peak Shadow	1190 m (3,904 ft)	*1080 m (3,543 ft)	+10.2%
Crater Rim Shadow Point 1	3484 m (11,430 ft)	**2320 m (7612 ft)	+17.7%
Crater Rim Shadow Point 2	2954 m (9,692 ft)		
Crater Rim Shadow Point 3	1754 m (5,755 ft)		

*Chart value is a single point measurement on opposite crater floor (LAC77)

** As compared to the average of the first 3 rim measurements (2731 m)

Table 1. Alphonsus Measurements

The reference chart/catalog values shown in Tables 1, 2, and 3 are from the Lunar Aeronautical Charts and the program *Virtual Moon Atlas (VMA)*. (see References) The Alphonsus measurements shown in Table 2 show how the crater rim changes height with a low spot near the center of the rim looking from the east. The crater center Longitude and Latitude and the diameter are in close agreement with the catalog values.

When repeating the shadow measurements at different Colongitude values, it is important to make sure you are measuring from the same point on the rim of the crater. This will allow you to trend the measured value for that specific point on the rim over time. Several measurements made at the same Colongitude can be averaged and the scatter of the data can be used to estimate the precision of the measurement. You can use the program VMA to calculate the time and date at your location for a given Colongitude value so that you can image at those times every month to gather your data. Over time, a record of the measurements will show you how your imaging technique has improved the resolution of your images.

Figure 8*. Aristarchus & Herodotus. Rik Hill, Tucson, Arizona, USA, 26 April 2010, 0502 UT. Colongitude, 28.1°, north-up, east-right, Celestron C-14 SCT f/22, DMK21AU04 CCD Camera + 2x Barlow. Seeing, 8/10.*

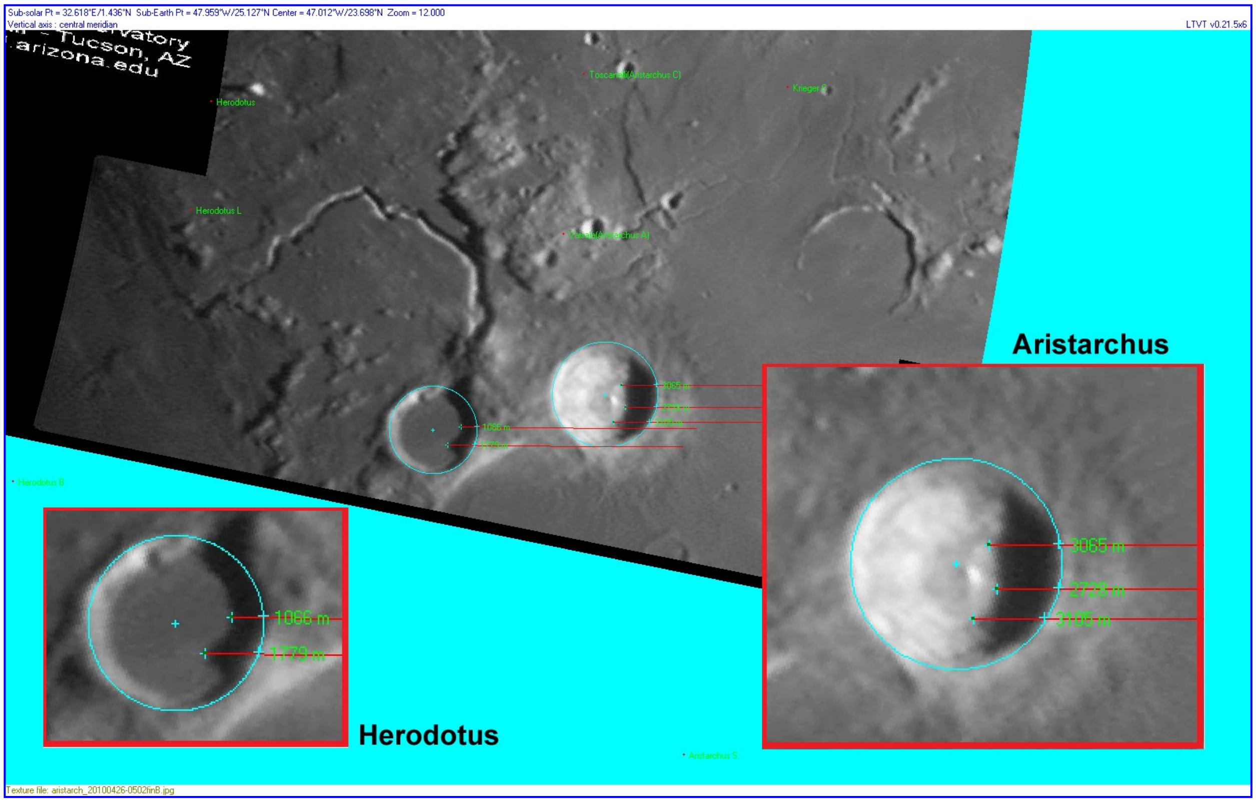

Figure 9. *Aristarchus & Herodotus LTVT Measurements. Rik Hill, Tucson, Arizona, USA, 26 April 2010, 0502 UT. Colongitude, 28.1°, north-up, east-right, Celestron C-14 SCT f/22, DMK21AU04 CCD Camera + 2x Barlow. Seeing, 8/10.*

Parameter	Measured Value	Chart/Catalog Value	Diff
Selenographic Longitude	W47°20’	W47°30’	- 0°10’
Selenographic Latitude	N23°51’	N23°44’	+ 0°07’
Crater Diameter	40.5 km (25.2 miles)	40.0 km (24.9 miles)	+ 1.3%
Crater Rim Shadow Point 1	3065 m (10,055 ft)	*2660 m (8727 ft)	+12.7%
Crater Rim Shadow Point 2	2828 m (9278 ft)		
Crater Rim Shadow Point 3	3105 m (10,187 ft)		

*Chart value is a single point measurement (LAC39). As compared to the average of the 3 rim measurements (2999 m).

Table 2. Aristarchus Measurements

Parameter	Measured Value	Chart/Catalog Value	Diff
Selenographic Longitude	W49°42’	W47°50’	- 0° 08’
Selenographic Latitude	N23°25’	N23°15’	+ 0° 10’
Crater Diameter	33.6 km (20.1 miles)	35.0 km (21.7 miles)	- 4.0%
Crater Rim Shadow Point 1	1066 m (3,497 ft)	*1440 m (4,724 ft)	- 1.3%
Crater Rim Shadow Point 3	1779 m (5,837 ft)		

*Chart value is a single point measurement (LAC39). As compared to the average of the 2 rim measurements (1422 m)

Table 3. Herodotus Measurements

In the next few months, I will be establishing the optimum Colongitude for each of the craters in the SAP and the selenographic longitudes and latitudes of the crater rim locations for shadow measurements. That way we all can make repeatable measurements every month and start to understand if we have any odd occurrences going on in these craters with this additional data.

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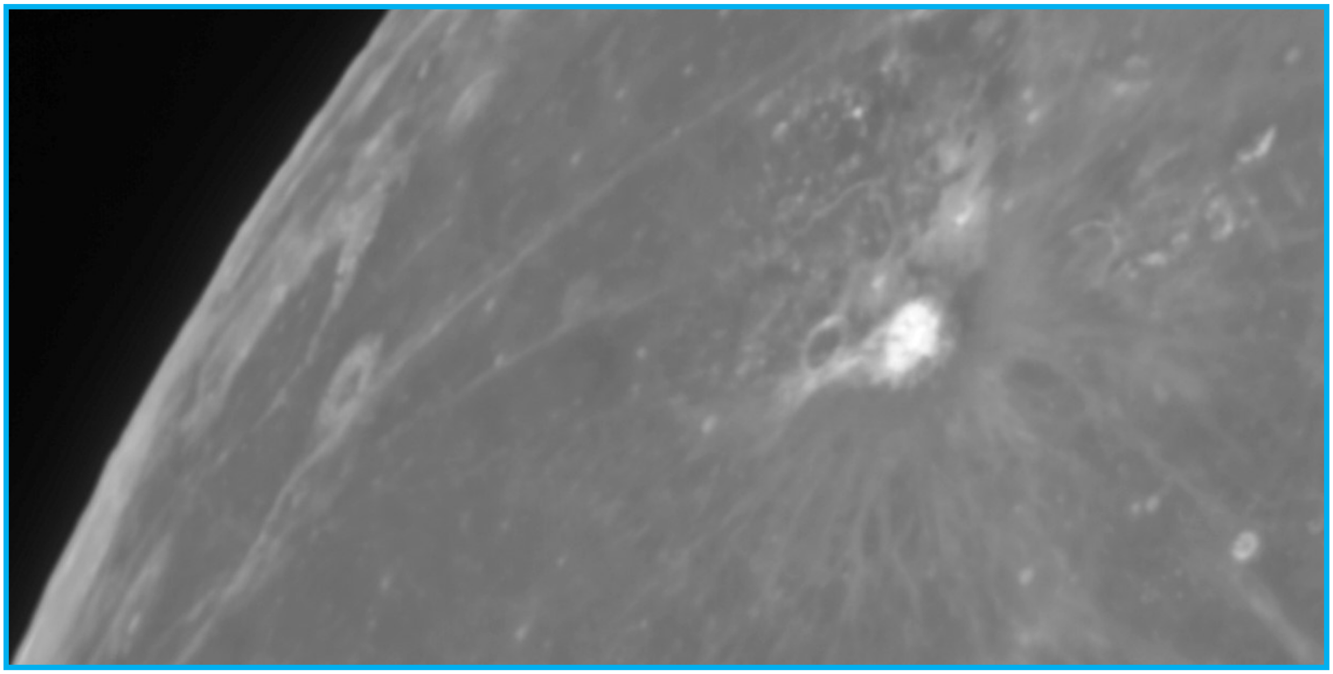
North of Aristarchus

Rik Hill

In the wide channel between Oceanus Procellarum and Mare Imbrium, from Aristarchus to Mairan, are scattered some interesting features worthy of scrutiny. Here you can see Aristarchus (41 km diameter) in the lower left corner and Mairan (also 41 km) at the upper edge. The diameter is where the similarities between these two ends. Aristarchus is the highest albedo of any crater on the visible disk of the Moon. It has been the site of many reports of transient events ever since the time of William Herschel who believed this to be an active volcano, now known to not be true. It is also very young at 175 million years old. Above Aristarchus is an arc open towards the bright crater. This partially flooded crater is Prinz with Mons Harbinger sparkling in the early morning light a little farther on. The crater Krieger (22 km) is filled with shadow to the left or west of these mountains. To the east are two more craters in Mare Imbrium. The larger is Delisle (26 km) and south of it is Diophantus (19 km). Working our way north and west (left) from Delisle we come to a small crater Gruithuisen (17 km) (pronounced Grooth-wee-sen). Above it the three odd-shaped mountains, the upper two of the trio are Mons Gruithuisen Delta on the right and Mons Gruithuisen Gamma on the left. These are two large lunar domes formed from the upwelling of magma (lavas) from cracks in the lunar surface at some time in the past. Gamma has a small near-central pit on its summit as well, not seen here because of the shadow. We end with Mairan, north of these domes.

North of Aristarchus, *Richard Hill, Tucson, Arizona, USA. 12 August 2019 0340 UT, colongitude 46.8^o, 8" f/20 Mak-Cass, Skyris 445 m camera, 610 nm filter, seeing 7/10.*

Recent Topographical Observations



Aristarchus- Román García Verdier, Paraná, Argentina. 18 July 2019 0017 UT. 180 mm reflector, ZWO ASI120MC.

Aristarchus- Desiré Godoy Oro Verde, Argentina. 12 December 2016 0034UT. Astronomik ProPlanet 742 IR-pass. 200 mm. reflector (Meade Starfinder 8).

Recent Topographical Observations

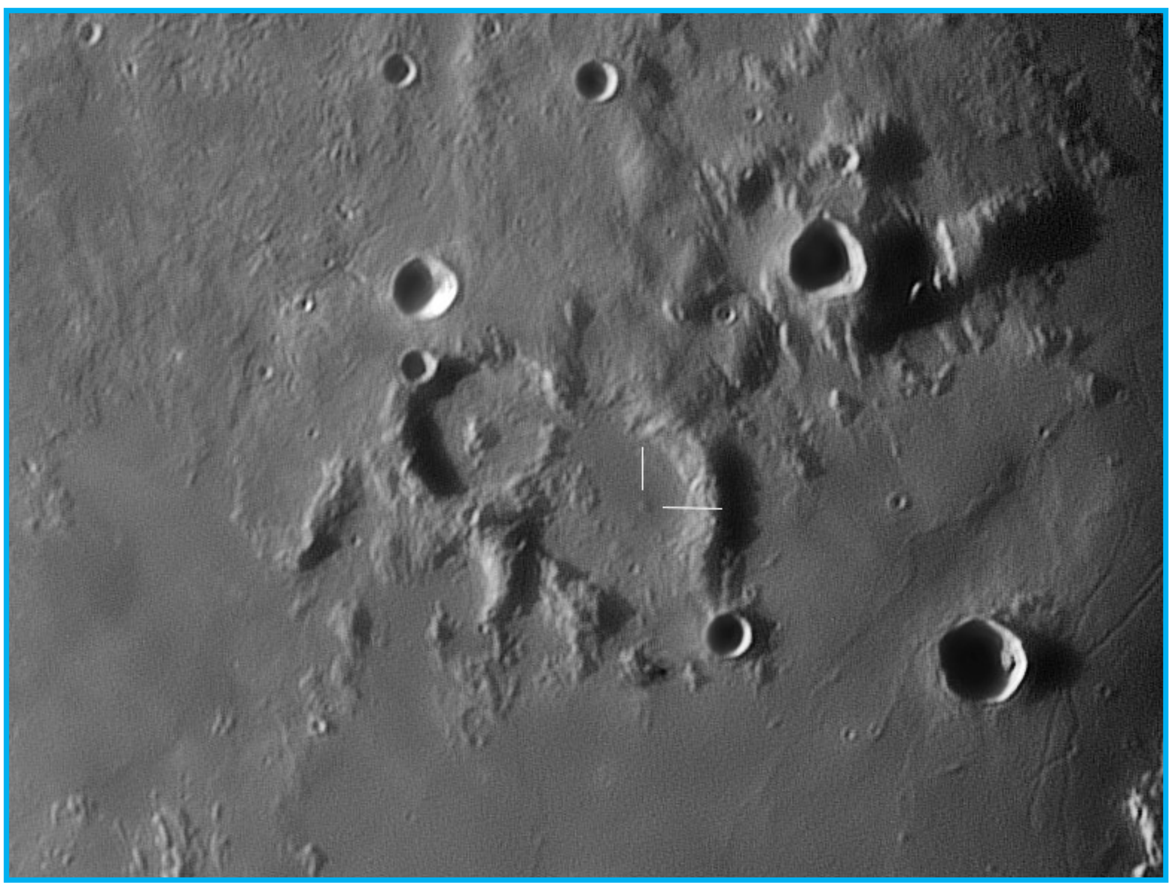
21 Day Moon –Jerry Hubbell, Wilderness, Virginia, USA. 22 August 2019 0918 UT. 6.5 inch Explore scientific ED APO refractor QHY163C Color CMOS Camera

Werner – Jairo Chavez,- Popayán Columbia. 11 July 2019, 0212 UT. 10" Dobsonian, Sony DSC-WX50.

Recent Topographical Observations

Burg - Francisco Alsina Cardinali, Oro Verde, Argentina. 06 August 2019 2327 UT. 200 mm refractor, 742 nm filter, QHY5-1 camera.

Menalaus Dome- Howard Eskildsen, Ocala, Florida, USA. 22 August 2019, 1134 UT. 6 inch f/8 refractor, Explore Scientific lens, 2 x barlow, W-8 yellow filter, DMK 41AU02.AS camera

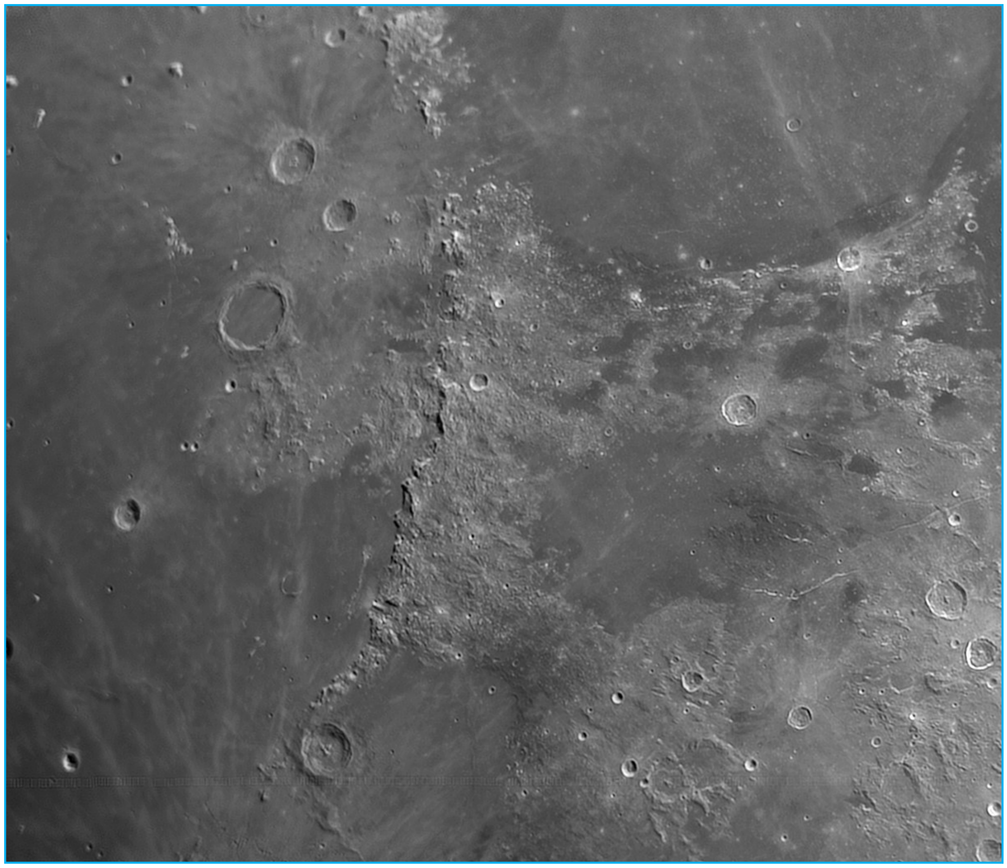


Recent Topographical Observations

Tycho – Jairo Chavez,- Popayán Columbia. 10 July 2019, 2352 UT. 10" Dobsonian, Sony DSC-WX50.

Plato– Walter Ricardo Elias, AEA - Oro Verde, Entre Rios, Argentina. 08 July 2019 2319 UT. Meade LX200 10 inch SCT, ZWO ASI 120MM/S.

Recent Topographical Observations



Conon– Walter Ricardo Elias, AEA - Oro Verde, Entre Rios, Argentina. 10 August 2019 2346 UT. Meade LX200 10 inch SCT, ZWO ASI 120MM/S.

Mare Nectaris– Alan Trumper- AEA - Oro Verde, Entre Rios, Argentina.07 August 2019 0021 UT. Meade LX200 10 inch SCT, Nikon D5100.

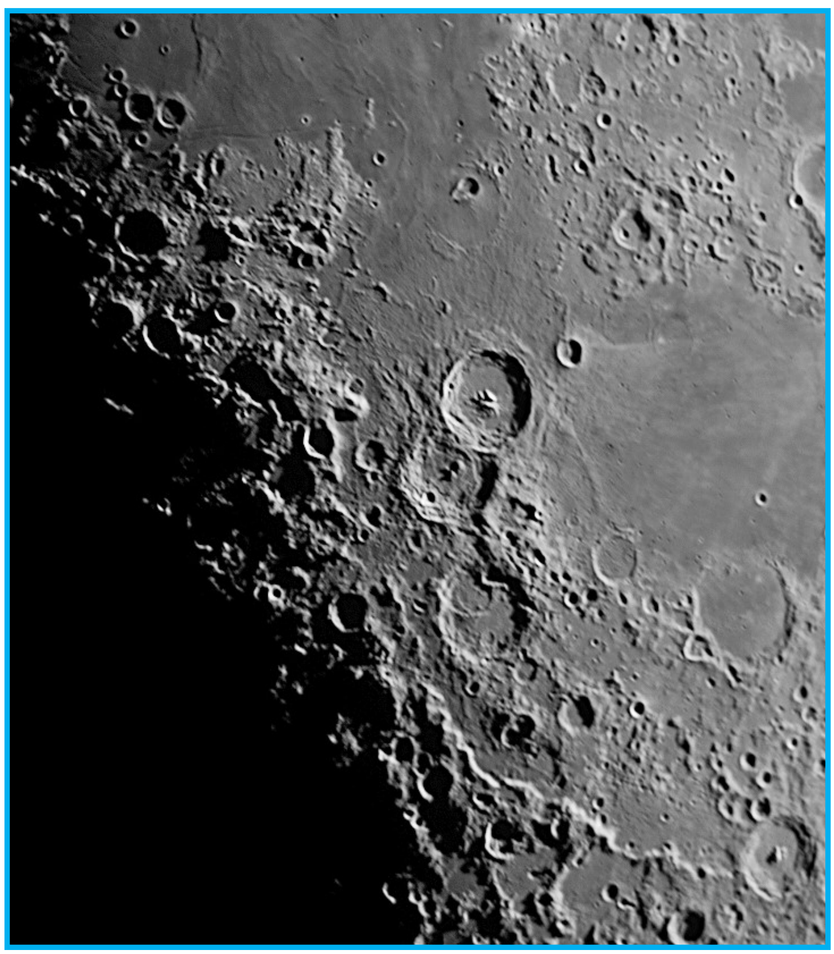
Recent Topographical Observations

Censorinus– Alan Trumper- AEA - Oro Verde, Entre Rios, Argentina.07 August 2019 0133 UT. Meade LX200 10 inch SCT, Nikon D5100.

Waxing Crescent Moon– Walter Ricardo Elias, AEA - Oro Verde, Entre Rios, Argentina. 04 August 2019 2144UT, Celestron CPC 1100, Canon Rebel T71.

Recent Topographical Observations

Messier to Columbo- Howard Eskildsen,Ocala, Florida, USA. 25 December 2018, 0352 UT. 6 inch f/8 refractor, Explore Scientific lens, 2 x barlow, W-8 yellow filter, DMK 41AU02.AS camera. Seeing 7/10, transparency 5/6.

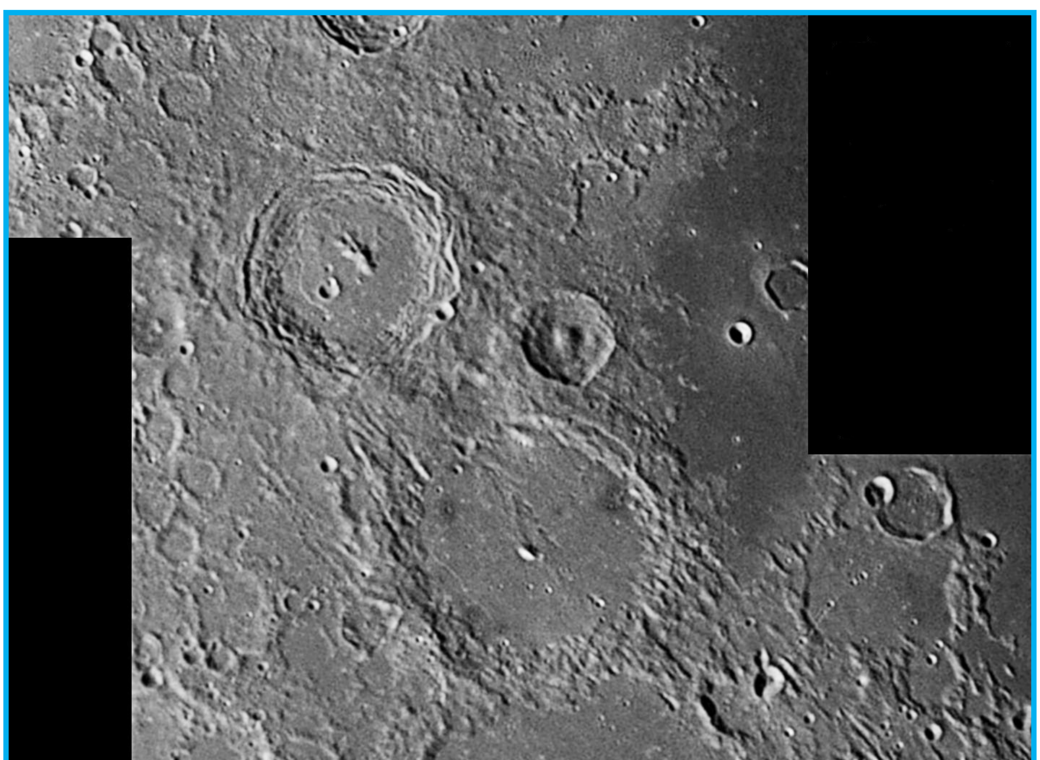


Theophilus - Francisco Alsina Cardinali, Oro Verde, Argentina. 06 August 2019 2334 UT. 200 mm refractor, 742 nm filter, QHY5-1 camera.

Recent Topographical Observations

Proclus Rays– Walter Ricardo Elias, AEA - Oro Verde, Entre Rios, Argentina. 10 August 2019 0005 UT. LX200 10 inch SCT, ZWO ASI 120 MM/S

Alphonsus Rik Hill, Tucson, Arizona, USA. 15 June 2016 0023 UT, 8" f/20 Mak-Cass, Skyris 445 m camera, 656.3 nm filter, seeing 8/10.



Fascinating Alphonsus

Alberto Anunziato

Alphonsus is undoubtedly one of the most fascinating craters on the Moon, for many reasons, among which its dark spots and its bright central peak stand out. In “Does anything ever happen on the Moon?”, 1942, a young Walter Haas referred to his teacher William H. Pickering's observations of the dark spots: “Near full moon the position of Alphonsus is marked by several striking black spots, which Pickering studied. I've found that the spots are darkest near noon, behavior he attributed to vegetation; and he discerned in the center of each spot a minute craterlet ”(page 7), the explanation would be that the vegetation would tend to grow (and be observed telescopically as dark spots) when the heat of the Sun is higher, dark spots were considered forested formations emerged in especially warm areas of our satellite generated by the heats of the volcanoes In 1958 the Soviet astronomer Nikolai Kozyrev, intrigued by the obscuration that Dinsmore Alter had photographed on the Alphonsus floor in 1956, obtained a spectrogram indicating the luminescence of molecular carbon gas (C_2) escaping from what he believed the volcanic central peak of Alphonsus, although it was later found that they were not volcanic hot gases but that the observation would be consistent with an outcrop of gas from the interior, favored by the fractured floor of the crater. Today we know that the 2 kilometers high central peak of Alphonsus is especially bright because it is formed by anorthosite. So interesting was Alphonsus, and the controversy between volcanists and impactists, that the first mission of the Ranger series that scientists managed to send to a goal of scientific value (and not referring to future Apollo missions) was Ranger 9, that crashed near the central peak of Alphonsus in 1965, sending the best lunar photos up to that time. As Don E. Wilhelms tells in "To a Rocky Moon," one of the most fascinating lunar books I've read, "It was agreed that Ranger 9 would look for anything peculiar on the Alphonsus peak and would examine the dark-halo craters by plunging to a compromise intermediate point”. The spectacular images of the approach to Alphonsus of the Ranger 9 were the first “live from the Moon” broadcast in the history of television and the proof of the value of the images, which were disdained by scientists as mere amusement. And also found no volcano in the center of Alphonsus. For a time they were a mystery, but the dark spots that can be seen in Alphonsus's photograph are deposits of volcanic ash, the evidence of recent volcanic activity for the terms of selenite geology, as are the cracks that fracture the floor of the crater. These dark spots are not easy to find because they are only visible near the full moon, a moment of the mooning avoided by astrophotographers because of the lack of contrast that makes the Moon appear “flat”, but this is one of the wonders that those who refrain from the full moon miss.

After the Ranger 9 mission, the fascination for Alphonsus remained. In the workshop of Lunar Science and Exploration of Santa Cruz in July 1967, it was considered as an objective: “An all-out, week-long, dual-launch mission would attack the crater Alphonsus, whose many and diverse features had attracted the longing gazes of planners ever since the days of Kozyrev and Ranger 9 and would continue attracting them until the landing site for Apollo I7 was finally chosen. After the astronauts had finished this complex mission and gone home, the LSSM would crawl out and head 750 km across the rugged central highland "backbone" of the Moon towards Sabine and Ritter, the twin putative boilers photographed by Ranger 8 and Lunar Orbiter 5” (To a Rocky Moon, page 175).

Alphonsus was a “perennial contender” (in the words of Wilhelms) at each election of the Apollo missions landing sites; he even integrated the Apollo 17 final list along with Gassendi and Taurus-Littrow. Quoting Don Wilhelms once more (page 107): “The legacy of Ranger 9 is, as usual, only partly what the experimenters thought it would be. Alphonsus fascinated them because of all its special features. Its central peak was thought to be volcanic, but that idea began to be weakened by the Ranger 9 pictures. Kozyrev's gas lingered a little longer but finally dissipated. The dark craters on the floor were thought to be volcanic, and remain so today in the minds of most investigators. The floor was, and still seems, different from the maria. The Alphonsus walls were thought to contain old highland rocks, and still are. This list would be trotted out many times in subsequent years as the targets for Lunar Orbiter photography and the sites for Apollo landings were chosen”.

Alphonsus, Alberto Anunziato, Oro Verde, Argentina. September 11, 2016 0048 UT. Celestron 11" Edge HD, QHY5-II.

Grimaldi*, David Teske, Louisville, Mississippi, USA. 26 July 2019 1024 UT. Colongitude 200.1°. Seeing 5/10. 180 mm Mewlon, ASI120m camera.*

Heading to the Far East, I Mean West
David Teske

In this image, I see a number of dark patches on the far western limb of the Moon. It was actually in 1961 that the International Astronomical Union changed the cardinal points on the Moon, so now the "Eastern Sea", Mare Orientale is on the western limb. This was done to accommodate future astronauts on the Moon so that the Sun would rise in the east and set in the west. The most obvious dark patch in this image is the crater Grimaldi. Grimaldi is actually a multi-ring basin, with its outer wall, only partially remaining, has a diameter of 400 km. Lava flooded the central portion of the crater, with a diameter about 230 km. Grimaldi's dark floor is a little lighter in tone to the north, where it was dusted by ray material from Oblers A 400 km to the north. With an ancient age of some 4 billion years old, the mare-like fills of Grimaldi and Riccioli provide targets for crater counts. The modeled ages are 3.25 billion years old for western Grimaldi lavas, with eastern portions being perhaps 750 million years younger. No ejecta from the Orientale basin cover these lava patches, so they must be younger than the 3.84 billion year old age of the Orientale impact. Do you agree that the floor of Grimaldi is darker than the lavas of Oceanus Procellarum, or is this just a contrast illusion? On the dark floor of Grimaldi are rilles and a large volcanic dome, but they are not visible at this high lighting. The walls of Grimaldi are not continuous. Most of the bordering wall is around 1,200 m tall, but there is one peak about 2,750 m tall. Grimaldi is the smallest basin to have a mascon.

Northwest of Grimaldi is the large, complex 145 km wide crater Riccioli. This crater was named after Giovanni Baptista Riccioli, the Italian philosopher, theologian, and astronomer who lived from 1598 to 1671. He was the first to systematically name lunar craters, including this crater which bears his name. If you were naming craters, would you name this crater after yourself? The northern portion of the crater is lava-flooded. Like Grimaldi, the floor of Riccioli sports numerous linear rilles that are not visible at the lighting conditions of this image. The walls are much eroded and not higher than 1,200 m. The whole of Riccioli and the surrounding area is overlain with texture radial to the Orientale impact basin to the south. Small impact crater superimposed on Riccioli's dark lava patch yield an age of 3.48 billion years old, again younger than the Orientale impact.

There is a wealth of dark craters and patches in this area on the far western lunar limb. Just about due south of Grimaldi is the oval, dark floored crater Crüger. With a diameter of 45 km, the dark floor gives an illusion that Crüger is larger than it actually is. Occupying the center of a larger, less distinct crater with a diameter of 120 km, Crüger has a narrow bright rim that is only 500 feet higher than its floor. Possible explanations for the origin of Crüger is that it was once a standard crater that filled with lava almost like Wargentin, it could be a secondary crater of the Orientale impact, or perhaps it is strictly of volcanic origin. West of Riccioli is a small mare patch of lava that is part of the crater Schlüter. Just northwest of Crüger is a horseshoe shaped mare patch, belonging to Lacus Aestatis, the Lake of Summer. It is actually composed of two unconnected dark lava flows that occupy part of the floor of the crater Rocca A (diameter 64 km). West of Grimaldi near the limb is the elongated "S" shaped Lacus Autumn. The Lake of Autumn lies inside the Montes Cordillera and has a surface area of 3,000 km^2. Moving even closer to the limb of the Moon lays the Lacus Veris, the Lake of Spring. With a surface area of 12,000 km^2, Lacus Veris lies of the inner edge of the Montes Rook. Beyond that and on the limb of the Moon is Mare Orientale, which needs even better libration to get a decent view.

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Herodotus Omega Dome

Howard Eskildsen

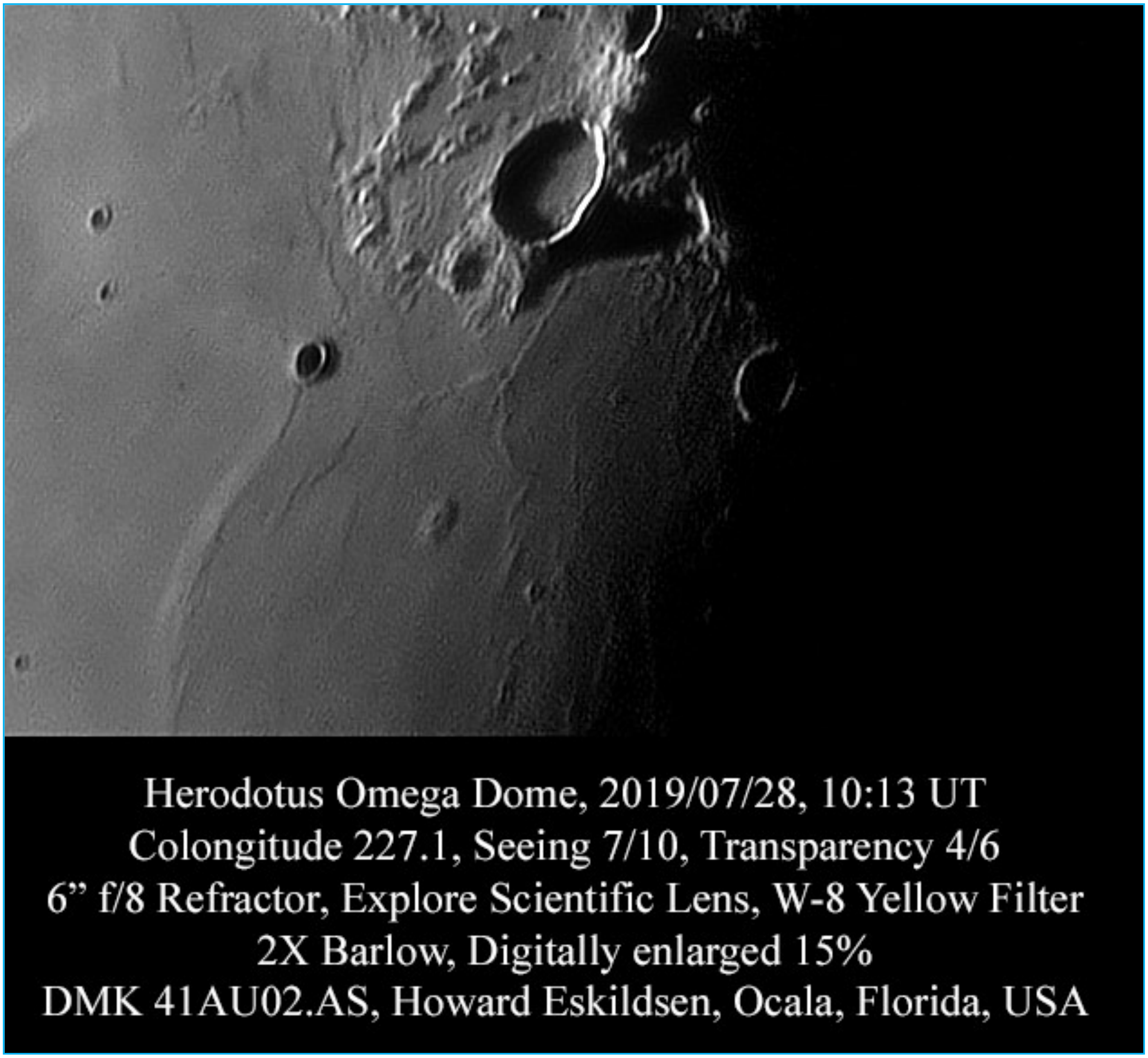

Fig.1

Herodotus Omega dome was imaged on July 28, 2019, 10:13 UT, using a six-inch, f/8 refractor, 2X Barlow, and a DMK 41AU02.AS camera (Fig. 1). The image was calibrated with Lunar Terminator Visualizing Tool (LTVT) and was used to estimate dome coordinates. Figure 2 shows the calibrated image, set to overhead view, with a 13.5 km circle drawn around the dome and the center marked. LTVT coordinates for the estimated center of the dome were -50.4^{o} longitude and 20.3^{o} latitude. A comparison with LROC QuickMap and the Virtual Mean atlas are shown below:

Longitude	Latitude	Source
-50.35°	20.27°	LTVT from calibrated image 2019/07/28 10:13 UT
-49.99°	20.25°	LROC QuickMap
-50.0°	20.3°	Virtual Moon Atlas

The LTVT coordinates are within 0.4 degrees longitude and <0.1 degrees latitude of the LROC coordinates. I would expect a greater discrepancy in the longitude due to foreshortening from limb proximity.

Fig. 2

On the LTVT image the dome appears to be about 13.5 km in diameter. The vent is visible on the telescopic image per Figure 1 and Figure 2. Using the overhead LTVT projection, its size was estimated at 2.9 km length and 1.5 km wide. Due to the very small area measured on that image, however, there is a large margin of error.

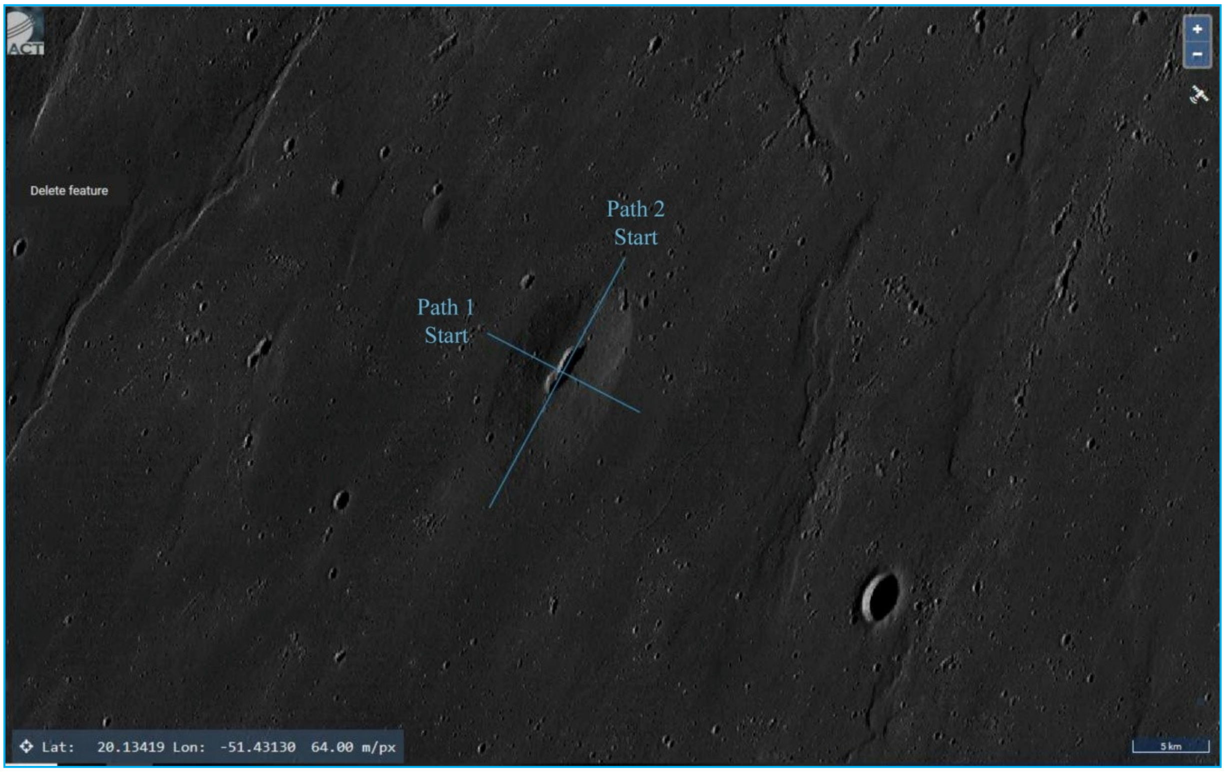

Fig.3

The LROC QuickMap was used to measure the length, width and elevations of the dome and the central vent. Figure 3 shows the sampling paths across the dome. Path 1 runs approximately from west to east a Path 2 runs from north to south. The paths were started a short distance from the dome and ended a short distance beyond in each case. Elevation data are relative to the mean lunar elevation.

Two estimates of each elevation and distance point were taken, one using the GLD100(m) curve and one from the SLDEM2015+LOLA(m). (Note: GLD100(m) uses stereoscopic elevation estimates and SLDEM2015+LOLA(m) uses laser altimetry.) Excel was used to calculate dome diameters from the data, as well as rim and vent elevations above the adjacent surface.

Dome height was calculated as the mean of the rim elevations measured. The dome diameter was calculated as the geometric mean of the west-east diameter (minor axis) and the north-south diameter (major axis), as recommended for noncircular domes (Lena et al., 2013, 23).. Slope was calculated using the formula: average slope = arc tan (2*h/D) where h=height and D=diameter. (Lena et al., 2013, 27). Vent size and depth were also calculated.

Path 1 chart is shown in Figure 4 and corresponding measurements and calculations are seen in Figure 5. The Path 2 chart is shown on Figure 6, and corresponding data on Figure 7.

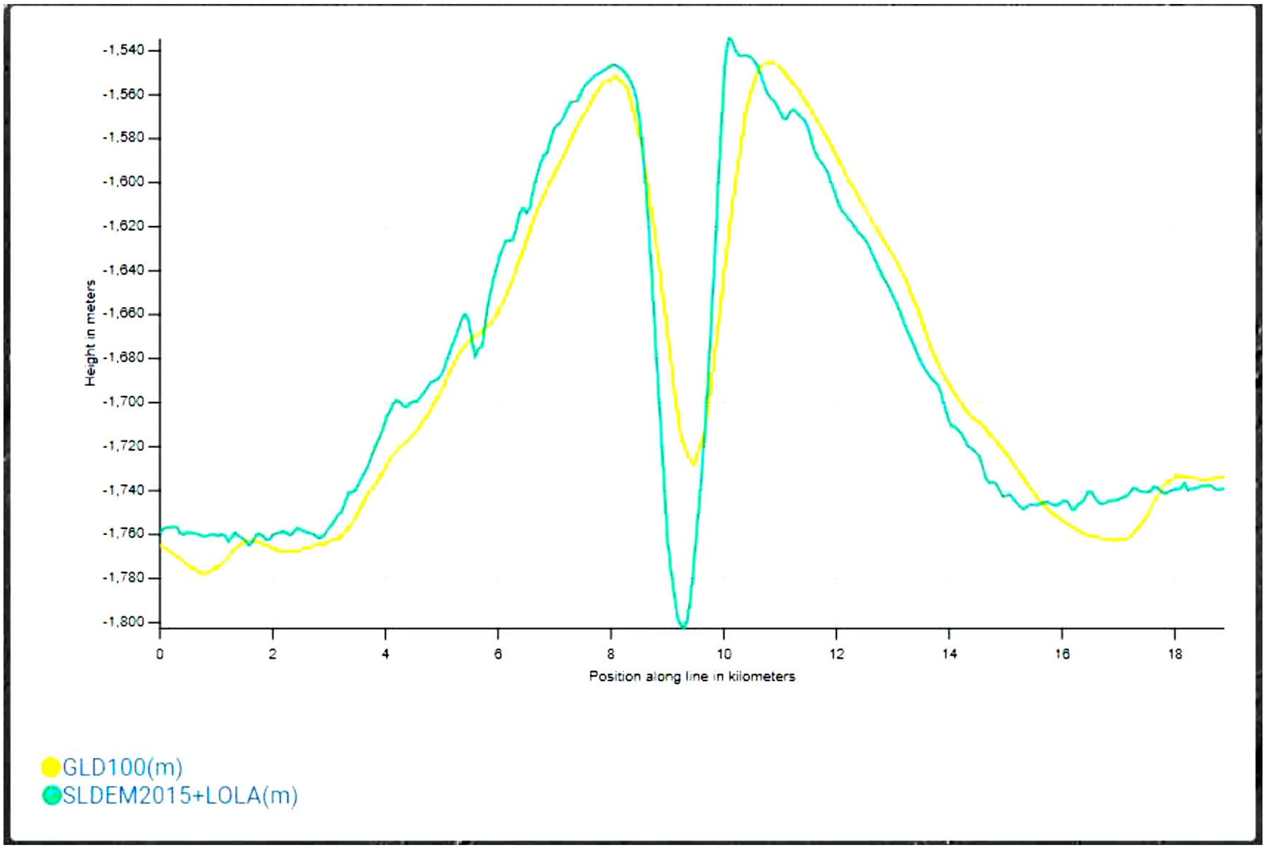

Fig. 4

Fig. 5

LROC Measurements Herodotus Omega (elevation in meters, distance in kilometers)

LROC QuickMap Path 1 Measurements

		Δ From Mean Lunar Elevation				Distance from start of Path		
			SLDEM2015+	GLD-LOLA			SLDEM2015+	
Path 1		**GLD 100**	**LOLA**	**Average**	**Path 1**	**GLD 100**	**LOLA**	**Average**
Elevation B1	**(west base)**	-1762	-1762	-1762	**D1**	3	2.7	2.85
Elevation B2	**(west vent rim)**	-1552	-1546	-1549	**D2**	8.1	8.1	8.10
Elevation B3	**(vent floor)**	-1726	-1802	-1764	**D3**	9.5	9.3	9.40
Elevation B4	**(east vent rim)**	-1544	-1534	-1539	**D4**	11	10.2	10.60
Elevation B5	**(east base)**	-1762	-1748	-1755	**D5**	16.8	15.4	16.10
Average Dome Base Elevation		-1762	-1755	-1758.5	**Dome Width (km)**	13.80	12.70	13.25
West Rim Height		210	209	209.5	**Vent Width (km)**	2.90	2.10	2.50
East Rim Height		218	221	219.5	**Dome Height (m)**	214.00	215.00	214.50
Mean Rim Height		214	215	214.5				
Vent Depth From Rim Ave. Elevation		178	262	220				

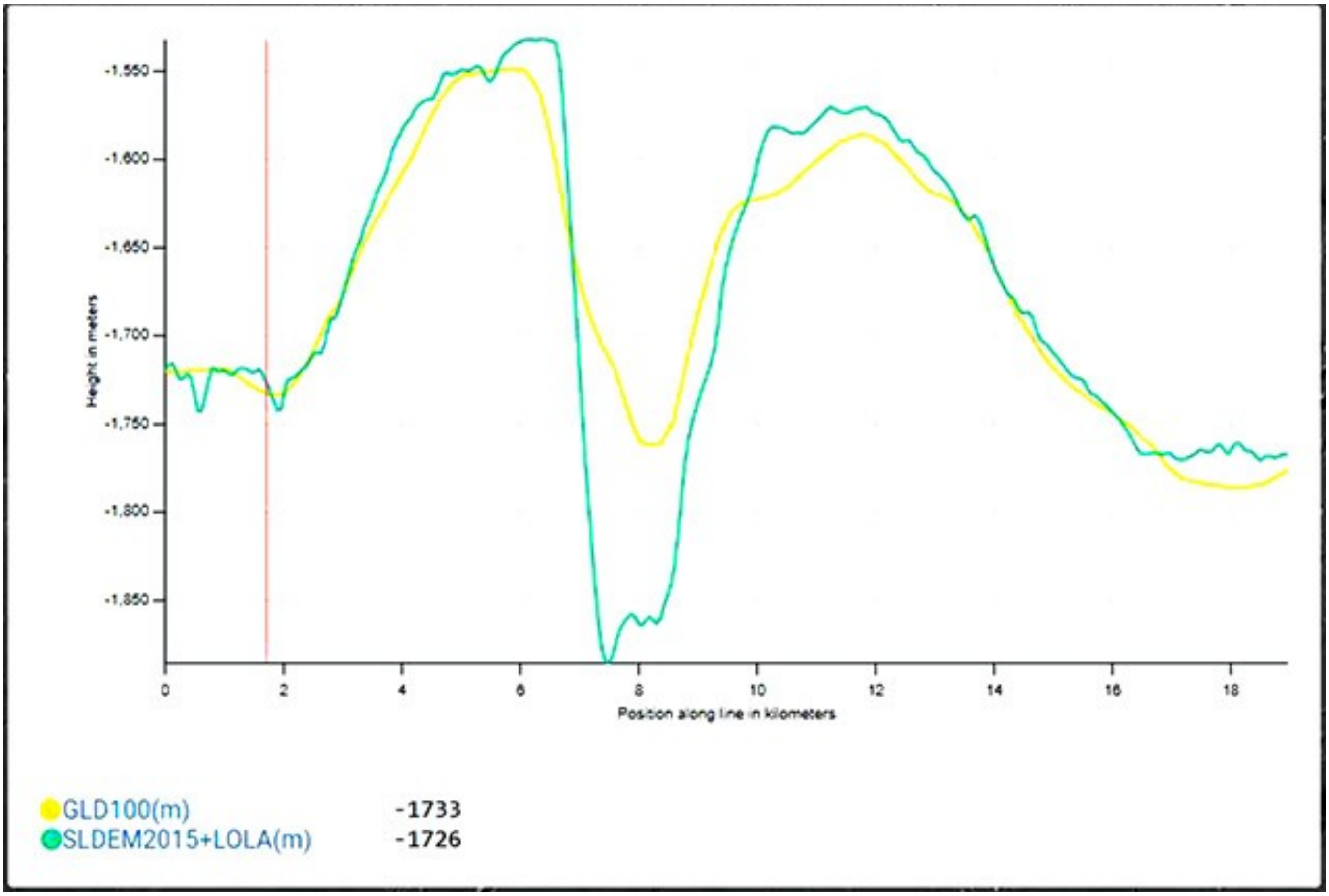

Fig. 6

Fig. 7

LROC QuickMap Path 2 Measurements

		SLDEM2015+		Distance		SLDEM2015+	
Path 2	**GLD 100**	**LOLA**	**Average**	**Path 2**	**GLD 100**	**LOLA**	**Average**
Elevation B1 (north base elevation)	-1725	-1725	-1725	**D1**	1.90	1.90	1.90
Elevation B2 (north vent rim)	-1555	-1540	-1547.5	**D2**	6.00	6.20	6.10
Elevation B3 (vent floor)	-1760	-1890	-1825	**D3**	8.20	7.80	8.00
Elevation B4 (south vent rim)	-1590	-1570	-1580	**D4**	9.60	10.30	9.95
Elevation B5 (south base elevation)	-1780	-1770	-1775	**D5**	17.20	16.60	16.90
Average Dome Base Elevation	-1752.5	-1747.5	-1750	**Dome Width (km)**	15.30	14.70	15.00
North Rim Height	195	210	202.5	**Vent Width (km)**	3.60	4.10	3.85
South Rim Height	160	180	170	**Dome Height (m)**	177.50	195.00	186.25
Mean Rim Height	177.5	195	186.25				
Vent Depth From Rim Ave. Elevation	187.5	335	261.25				

Herodotus Omega Dome properties measured from LROC QuickMap are as follows:

Longitude: -49.99° Latitude20.25°	
Height (Arithmetic Mean, m)	200.4 m
Width (Geometric Mean, km)	14.1
h/W ratio	0.014
Slope	1.6°
Vent Length (km)	3.85
Vent Length (km)	2.5
Vent Depth (m)	241

The dome height was estimated from the mean of the vent rim measurements. If the dome height were estimated from the highest rim elevation, the slope would be slightly greater. Also, it is interesting to note that the vent floor is lower than the mean elevation of the surrounding terrain.

Compared to measurements from the LROC QuickMap data, the LTVT longitude varies by about 0.4 degrees, and the latitude by less than by 0.1 degree, and the LTVT diameter is estimated about 0.6 km smaller than the geometric mean diameter calculated from the QuickMap data. The LTVT vent size estimate of 1.5 km by 2.9 km was a full kilometer short in each direction compared to the QuickMap, and illustrates the large error associated with measurements of very small areas with LTVT method.

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Rimae Ritter and Ritter 1 Dome

Howard Eskildsen

This lunar region (fig. 1) was originally imaged to show the domes associated with Menelaus, which are visible in the upper central photo. However, I was surprised to see rilles between Dionysius and Ritter on the central lower margin of the image. Where there are such rilles, there is likely subterranean volcanic intrusion with associated uplift of the area. The Virtual Moon Atlas (VMA) denotes a dome, Ritter 1 there, however, it is not noted on the Geological Map of the Julius Caeser Quadrangle of the Moon. The quadrangle does identify a crater chain which is just visible on this image at the shadow margin just northeast of Dionysius. On review with the LROC QuickMap, it could alternatively be considered a chain of collapse pits, but I believe that to be less likely.

Measurements of elevations and distances along the arrow paths on the image were made using the LROC Quickmap and were charted as seen on figure 2. The path chart at the top of the image runs from north to south and the lower path chart shows the west to east dimensions of the area. The intersection of the two paths lies at latitude 3.05° and longitude 18.11°. The VMA lists the dome coordinates as latitude: 3 ° 2 ' north and longitude: 18 12 ' east. The highest elevation on the north-south path lies about 6 km south of the intersection of the paths. Unfortunately, the north-south curve is still trending downwards where the image terminates, so the southern end of the downslope is not shown on this image nor in the corresponding north-south path chart. Review of the LROC QuickMap revealed that southern end of the rise is 24 km farther and has an elevation of -1054 meters relative to mean lunar elevation. Those data points were used in further calculations of diameter and elevation.

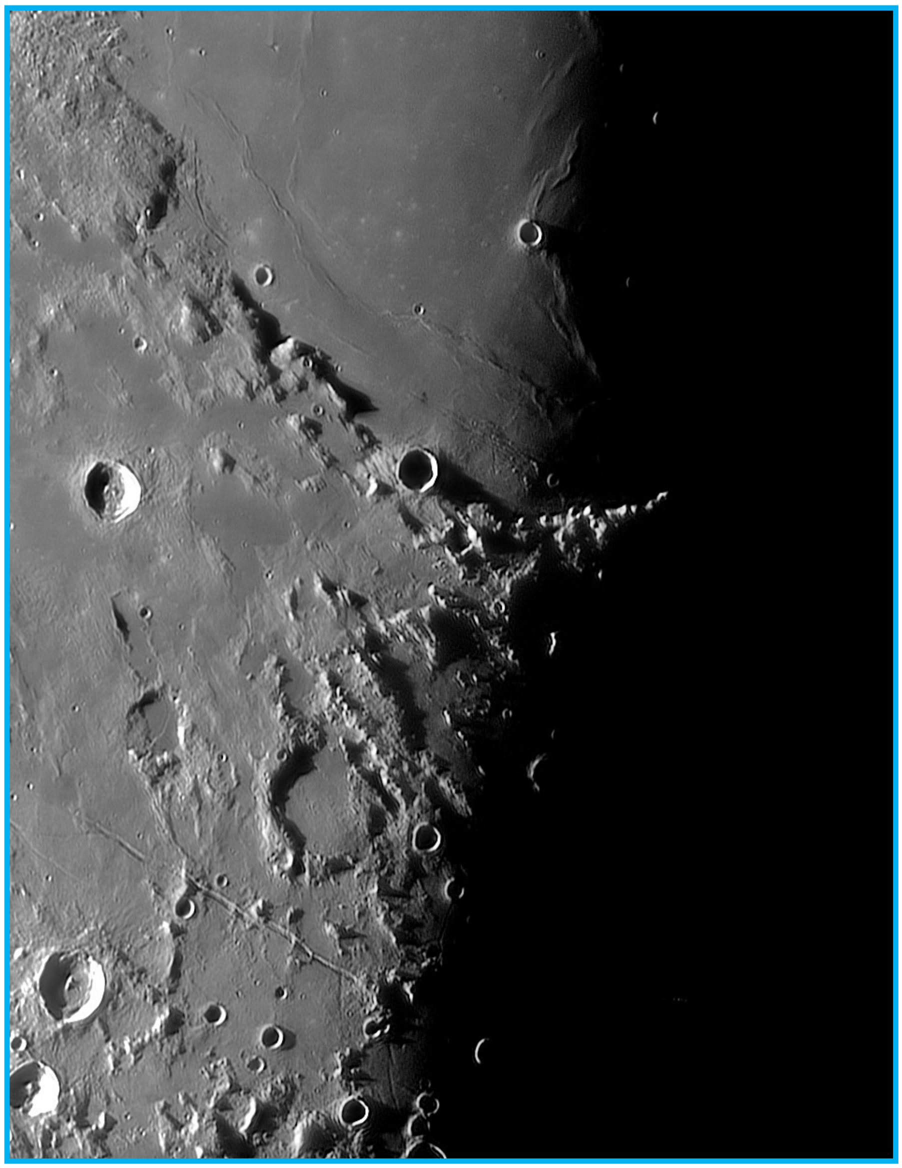
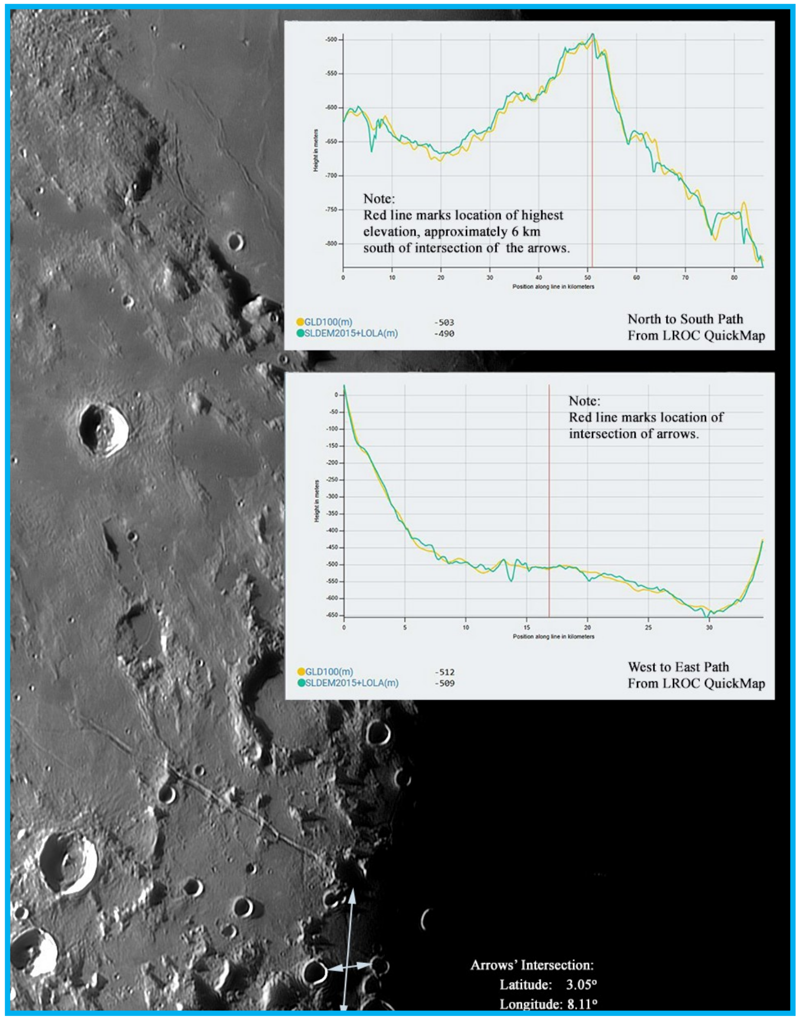


Figure 1 *Bessel to Dionysius, Howard Eskildsen, Ocala, Florida, USA. 21 August 1041 UT. 6 " f/8 refractor, 2 x barlow, W-8 tallow filter, DMK41AU02.AS camera. Colongitude 160.7^o, seeing 8/10, transparency 5/6.*

From the path charts and the updated southern dimensions, calculations of diameter, elevation, and average slope of the uplift were done as seen in figure 3. The arithmetic mean uplift is 214 meters above the average base elevation and runs 24 km west-east by 92 km north-south, with a geometric mean width of 48 km and an average slope of 0.522^o.

The Virtual Moon Atlas describes Ritter 1 Dome as "extrusive volcanism," however, I could find no signs of volcanic flows in the region using the LROC QuickMap, and its low slope would be more consistent with an intrusive dome. If this really is a dome, it would fit in to the intrusive class, In1. Per *Lunar Domes* by Lena, et al. page 135, In1 domes have diameters over 25 km and slopes between 0.4º and 0.6º.

Figure 2.



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LROC QuickMap Measurements Rimae Ritter Region
(elevation in meters, distance in kilometers)

QuickMap SLDEM2015+LOLA Path Measurements

North-South Path Elevations Relative to Lunar Mean			**N-S Distances From Start of Path**	
Elevation B1	(north base)	-660	D1	20
Elevation B2	(summit)	-490	D2	51
Elevation B3	(east base)	-1054	D3	112
Average Dome Base Elevation		-857	Dome Width (km)	92.00
Summit Height Above Base		367	Dome Height (m)	367
			H/W ratio	0.004
			Slope (radians)	0.008
			Slope (degrees)	0.457

QuickMap SLDEM2015+LOLA Path Measurements

Figure 3

West-East Elevations Relative to Lunar Mean			**W-E Distances From Start of Path**	
Elevation B1	(west base elevation)	-500	D1	8.00
Elevation B2	(summit)	-509	D2	17.00
Elevation B3	(east base elevation)	-640	D3	32.00
Average Dome Base Elevation		-570	Dome Width (km)	24.00
Summit Height		61	Dome Height (m)	61
			h/W ratio	0.003
			Slope (radians)	0.005
			Slope (degrees)	0.291

Summary:

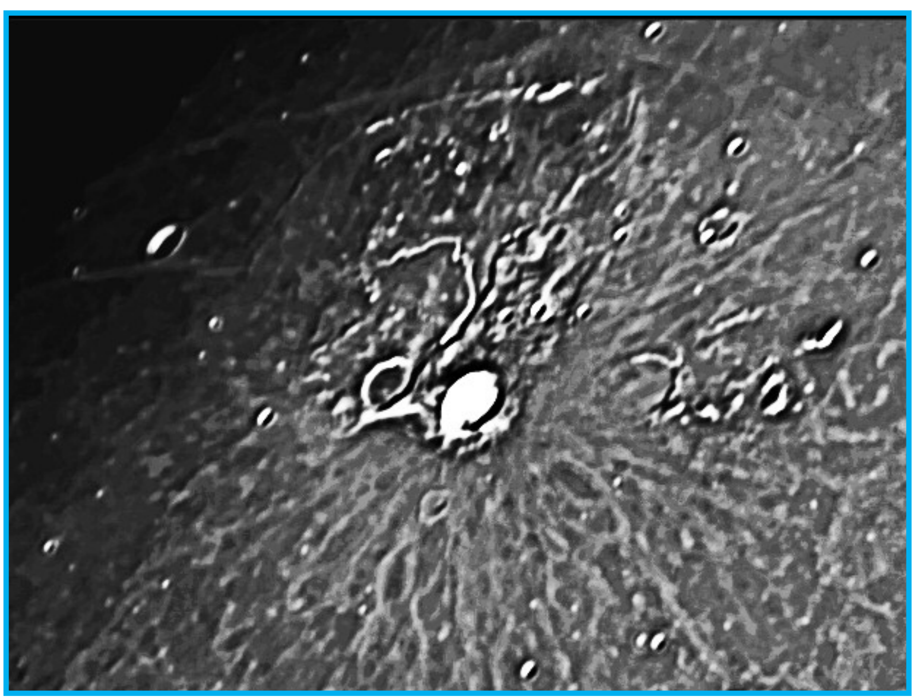
Arithmatic Mean Height (m)	214.0
Geometric Mean Width (km)	47.0
h/W ratio	0.005
Slope per GM Radians	0.009
Slope per GM degrees	0.522

Sailing the Smythii Sea
Rik Hill

With high sun over the lunar east limb at this libration we see Mare Smythii dominating the limb region. It's the large dark area near the limb from the middle of this image to nearly the lower edge. The particular processing used in this image shows the basaltic areas prominently, butter than what the eye will see. Above this large mare is a small patch or dark oval. This is the large flooded crater Neper (141 km diameter). Further away from the limb is a collection of dark areas with a dark crater of the east (right) and west side. The dark patches make up Mare Undarum. The east crater is Dubiago (53 km) and on the west side is Firmicus (58 km). Below is yet another dark patch. This is Mare Spumans, a 206 km diameter "sea'. On the left edge of the image we see a small portion of Mare Fecunditatis and at the bottom is a portion of the great crater Langrenus (136 km).

Mare Smythii and Peek *Richard Hill, Tucson, Arizona, USA. 12 August 2019 0333 UT, colongitude 58.4^{o}, 8" f/20 Mak-Cass, Skyris 445 m camera, 610 nm filter, seeing 6-7/10.*

Lastly, in Mare Smythii you can see a little white streak in the uppermost region of the mare. This is an extremely foreshortened view of the small crater Peek (14 km). It is only at such libration as this that you can get a peek at Peek!

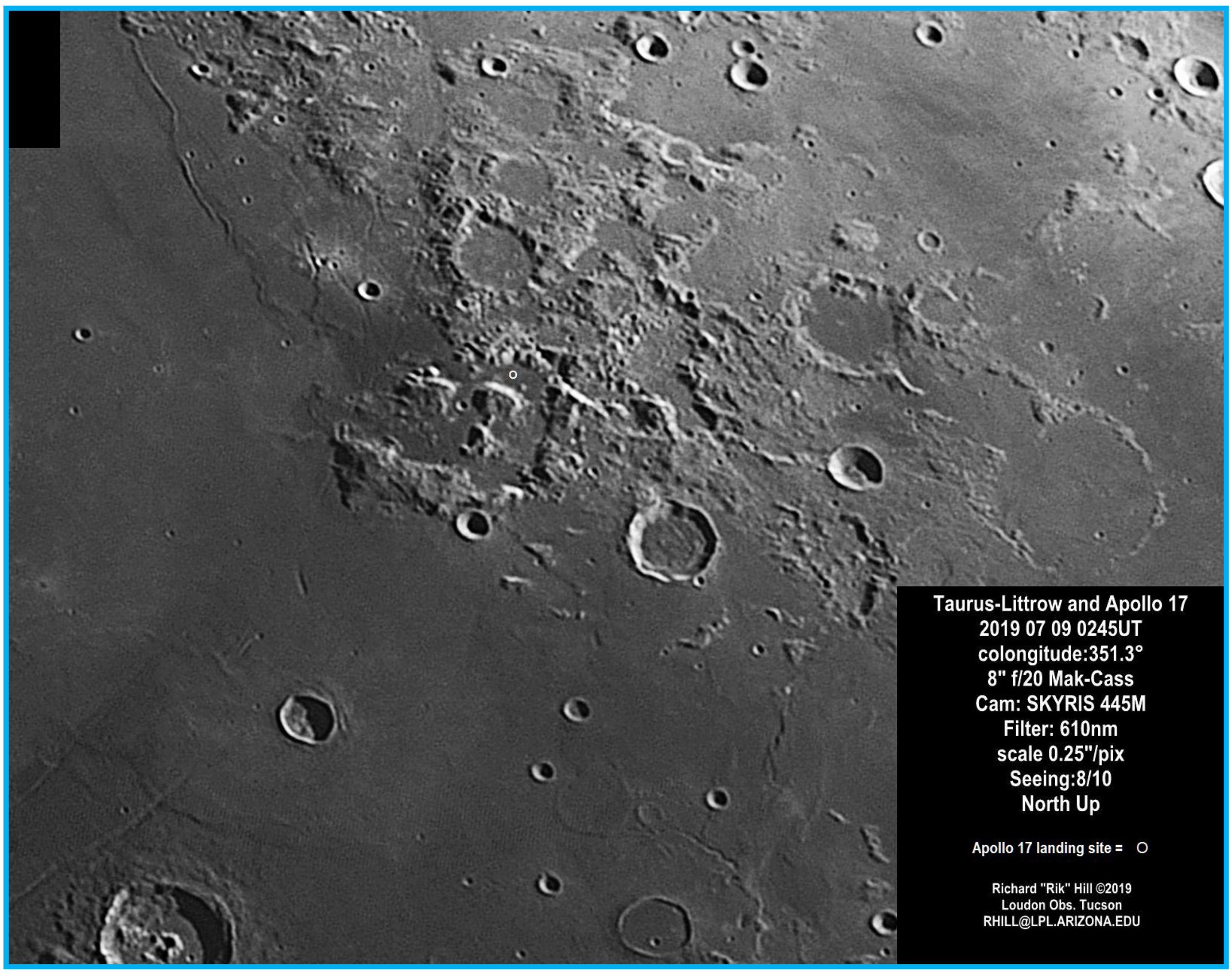


Aristarchus Processed to Show Ray System *Richard Hill, Tucson, Arizona, USA. 16 July 2008 0519 UT, 3.5" Questar, SPC900NC camera, UV/IR blocking filter, seeing 5/10.*

Taurus-Littrow - man's last steps
Rik Hill

Apollo 17 was our last manned mission to the Moon. The first two Apollo missions were the "safe" ones: go to the Moon, land, the astronauts do a little exploring and "returning them safely to Earth." Apollo 11 had 2.5 hours of EVA (Extra Vehicular Activity) during which time they collected 21.55 kg of samples. The EVA time and collections increased for each successive mission culminating on Apollo 17 at just over 22 hours in 3 EVAs on the surface with a total collection of 110.4 kg of geologic samples. This last mission was the only mission with a professional geologist, Harrison Schmidt a member of the crew.

In this image we can see the landing site for Apollo 17, in the Taurus-Littrow Valley, marked with an "o" above the center. Immediately above that marker is what was called North Massif and below it, brighter here, is South Massif that define the valley. All of the EVA activity with the rover took place between these mountains, an area just a bit larger than the marker itself. The large shallow crater above this marker is Littrow (32 km diameter), and below and a little to the right is a similar sized but deeper crater Vitruvius (31 km). To find the landing site locate these two craters and then look for the line of 4 mountains between them. The mountain chain points right to the crater Gardner (19 km) and above it is Miraldi (41 km). At the bottom of the image is the crater Plinius (44 km) partly cut off by the edge of the image and above it Dawes (19 km). There is much more to see here but the point is that you can take the average amateur astronomer telescope and easily see the area explored by our astronauts on Apollo 17!



Thermal Imaging of the Moon

Darryl Wilson

Brighter areas in the thermal image correspond to warmer areas on the lunar surface.

Darker areas fall into two categories. First, they often represent cooler areas on the lunar surface. Second, they sometimes show areas that emit a lower proportion of their thermal energy than their surroundings, even though the surface temperature is the same.

An example of the first category is easily seen on the eastern walls of many craters and mountains. Even walls that have been exposed to direct sunlight for several earth-days show less thermal emittance. In the current image, the crates Hercules and Atlas, in the northeastern quadrant, are good examples. They still show clear thermal shadows on the eastern interior walls even though they experienced sunrise about seven days earlier. There is no reason to suppose that the emissivity of craters is asymmetric in such a manner that would cause the western interior walls to emit more thermal energy than the opposite side. The obvious answer is that the western (eastern-facing) walls received sunlight earlier, and at a more direct angle, than the opposite facing walls. So they are warmer, and appear brighter in the thermal image.

The second category is more subtle, and a little more complicated. It may be best seen in areas where lunar rays are prominent. The bright rays may emit a lower proportion of their thermal energy than their darker surroundings, even though they are at the same temperature. An example in the current mosaic may be the diagonal ray that crosses Mare Serenitatis from the seven o'clock to the one o'clock position. It had experienced about six days of sunlight at the time of this image. One might expect that thermal equilibrium at the surface had been reached on the lunar surface by that time. If this is the case, then lower emissivity of the material that makes the ray would be the reason for the dark feature in the thermal image.

Alternatively, the rays may actually be at lower temperature due to surface self-shadowing the effect of rough ejecta. The best example in the current mosaic might be the diagonal dark streak that crosses the southwest wall of Mare Nectaris. If many large boulders were ejected along with the material that formed the ray, then the shadows that they cast during lunar morning would reduce the surface area that receives sunlight until a sufficiently large solar elevation angle had been reached. The fact that several small craters are visible directly along the path of the ray is evidence that there were probably many large boulders mixed in with the mass of ejecta that fell back to the surface.

Further discussion:

A comparison of the visible light image and the thermal mosaic shows a number of interesting patterns. One of the most obvious is the thermal shadow on the eastern wall of many craters and mountains persists for at least an earth week after lunar sunrise. This is at least weak evidence that the surface warms relatively slowly. Unfortunately, these images are not radiometrically calibrated, so we do not know what the temperature differences actually are. This means that it is possible that a small thermal difference on the walls might appear to be a large brightness difference in the images.

An interesting anomaly involves two notable craters, Langrenus and Posidonius. They appear cooler than their surroundings long after sunrise. Whether this is due to roughness on the crater floors or slower warming due to brightness of the floor surface material is not yet determined. A large scale pattern that is revealed upon inspection involves small, bright craters that appear notably dark in the thermal image. They include Proclus, two craters near Reichenbach and Stevinus, one on the western side of Mare Tranquillitatis, just north of Delambre, one east of and adjacent to Atlas, one inside Deslandres, one at Descartes (just south of the Apollo 16 landing site), and several others. Why many of the brightest small craters appear markedly darker in the thermal image, but some do not, is currently unexplained. Perhaps emissivity differences or surface roughness is responsible in each case. A single thermal image cannot provide enough information to answer the question, but a time series analysis, combined with visible light images may allow us to conclude with a reasonable degree of certainty what physical processes are at play.

Mosaic of several thermal infrared lunar images, Darryl Wilson, Marshall, Virginia, USA. 12 August 2019, 0230 UT. 18” Obsession Newtonian.

Visible light reference image, Darryl Wilson, Marshall, Virginia, USA. 12 August 2019 0333 UT. 80 mm APO refractor, Skyris 274C camera.

Of course, we could examine imagery from one of the lunar orbiters to accurately estimate the surface roughness anywhere on the moon, but I am focusing on analysis that can be conducted from our own backyards, using our own telescopes and our own cameras.

Many other interesting patterns emerge upon inspection and comparison between the visible and the thermal images. They all invite explanation, and the author hopes to provide more information in a future article

How the images were acquired and processed:

The visible light image was taken with a Celestron CCD imager and processed with Registax. The thermal images were taken using a commercially available product. They were processed using standard techniques including flat-fielding, stacking, and sharpening. The mosaic was generated by simply sliding the individual images around on a PowerPoint slide until they matched up. The author hopes to provide additional information regarding image acquisition and processing in a future article.

Conclusion:

Thermal imaging of the moon and planets is a brand new area that amateur astronomers can explore. It is quite similar to CCD imaging that swept the field 25 years ago. Remember when we were all learning about electronic image capture, flat fielding, dark frame subtraction, noise reduction, image sharpening, contrast enhancement, and other techniques? Well, thermal imaging builds on all of that. If you are an astronomer who is familiar with digital image capture and processing, you can quickly learn how to image in the thermal infrared region of the spectrum.

There are a few important differences, but there is less to learn than there was at the beginning of the CCD revolution. The reward is that you will be imaging in a part of the spectrum that our eyes can never see.

Note that this is not the same as the near-infrared spectrum that most CCD imagers (and videocameras with Nightshot capability) can see. Thermal infrared wavelengths are roughly 10 times longer than near-infrared wavelengths, and about 20 times longer than visible wavelengths. This is a region of the electromagnetic spectrum that carries heat information.

The reward is that you will be imaging in a part of the spectrum that our eyes can never see, and that you will capture information that has never before been seen by amateur astronomers. There are opportunities for original research. For example, subsurface lava tubes are suspected in some areas of the moon. If they are widespread, it is possible that they might cause a thermal anomaly at the surface that could be detected. Another opportunity involves imaging the heat effects of meteoroid impacts on the lunar surface. Amateurs have imaged several meteor strikes on the moon in recent years using CCD imagers. While these flashes last only a fraction of a second, the heat emitted might be visible for a much longer time. Analysis on the thermal curve over time could provide information about the impactor's kinetic energy. An analysis of the spatial distribution of the impactors, as well as their relative masses, over time could be used to estimate the three dimensional structure of the swarm.

Finally, the moon is not the only object that can be observed. The author has imaged Venus with enough detail to show that a crescent phase shows thermal equilibrium between the sunlit and the dark side. More detailed observations may reveal subtle temperature variations.

Hopefully, future observations of Mars will reveal surface details. This is most likely during perihelic oppositions, so the author looks forward to the one next year.

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAM

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Assistant Coordinator – David O. Darling - DOD121252@aol.com

Reports have been received from the following observers for Jul: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Censorinus, Curtis, Plato, Pytheas, and Swift. Bruno Cantarella (Italy - UAI) imaged the Montes Teneriffe. Maurizio and Francesca Cecchini (Italy – UAI) imaged the Montes Spitzbergen and the Montes Teneriffe. Jario Chevez (Columbia - SLA) imaged: Bullialdus, Plato, Tycho, Werner, and several features. Tony Cook (Newtown, UK – ALPO/BAA) imaged the partial lunar eclipse. Walter Elias (Argentina – AEA) imaged: Aristarchus, Boussingault, Censorinus, Gassendi, Kepler, Mare Fecunditatis, Mare Nectaris, Menelaus, Mons Pico, Proclus, Schmidt, and Theophilus. Valerio Fontani (Italy – UAI) imaged Mare Fecunditatis, Montes Teneriffe, Tycho, and several features. Cian Gonzalez (Argentina - AEA) imaged Picard. Facundo Gramer (Argentina – AEA) imaged Promontorium Fresnel. Avril Micaela Elias (Argentina – AEA) imaged Schmidt. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged Atlas, Lacus Mortis and the Apollo 16 & 17 landing site areas. Walter Latrónico (Argentina – AEA) imaged Aristarchus. Julien Quirin (France) imaged the lunar eclipse. Dave Scanlan (Baddesley, UK – BAA) imaged the lunar eclipse, Mare Frigoris, Mare Nectaris, Mare Tranquilitatis, and several features. Trevor Smith (Codnor, UK - BAA) visually observed the lunar eclipse. Thierry Speth (France) imaged Alphonsus, Aristarchus, Eratosthenes, Montes Teneriffe, Rumker, and Tycho. Robert Stuart (Rhayader, UK – BAA) imaged: Bela, Buckhardt, De La Rue, Endymion, Furnerius, Geminus, Helmholtz, Humboldt, Lame, Langrenus, Mallet, Mare Crisium, Neumayer, Petavius, Vega, Vendelinus, and several features. Franco Taccogna (Italy – UAI) imaged: Geminus, the lunar eclipse, Mare Fecunditatis, Montes Spitzbergen, Montes Teneriffe, and Torricelli B. Aldo Tonon (Italy – UAI) imaged the Montes Spitzbergen and the Montes Teneriffe. Alan Trumper (Argentina – AEA) imaged Plato. Román García Verdier (Argentina – SLA) imaged: Alphonsus, Aristarchus, Deslandres, Menelaus, and Tycho.

News: Chandrayaan-2, India's 2nd lunar mission, is now in orbit around the Moon and the lander/rover is due to touch down on 2019 Sep 06 UT 20:25. As yet I do not know whether this will be at the primary landing site: 22.78°E, 70.90°S or at the backup landing site: 18.47°W, 67.87°S. But if you want to monitor the area of the landing visually, then keep a look out for landing times/site selection on these two web sites: https://www.isro.gov.in/ https://www.isro.gov.in/chandrayaan2-home-0 . You should not normally expect to see anything of the event though a telescope – though there is always a very slight chance of detecting sun glint off the solar panels if the angles are right.

LTP reports: No LTP were observed in August although it was reported in the BAA's Aug-Sep Lunar Section Circular that on 2019 Jul 16 UT 21:30 Massimo Giuntoli (Italy) sketched a couple of apparent extensions of the lighter penumbral part of the eclipse into the darker umbra at either side of the Moon. This looked odd, however it was also recorded on an image by Peter Carson of the UK and simply turns out to be due to a narrow strip of bright highland on the SW limb of the Moon, and a thicker area of highland in the vicinity of Mare Crisium on the NE limb of the Moon, showing up in the umbra more so than the darker mare areas – So mystery solved!

Routine Reports: Below are a selection of reports received for July 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.

Boussingault: On 2019 Jul 05 UT 22:23 Walter Elias (AEA) imaged this crater under similar illumination to the following report:

Boussingault 1856 Apr 08 UT 20:00? Observed by Schmidt (Athens, Greece, 7" refractor) "Noted weak glows in the crater he tho't prob. due to wall reflections on the floor" NASA catalog weight=0 (not very likely to be a LTP). NASA catalog ID #131. ALPO/BAA Catalog weight=1.

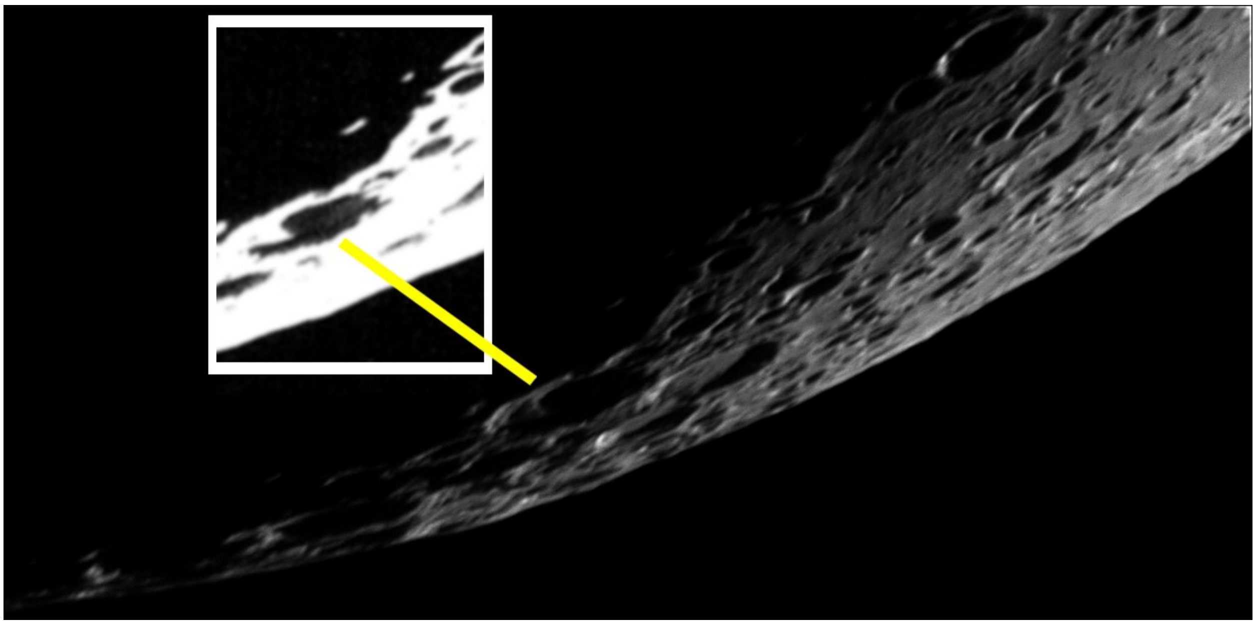


Figure 1. The Boussingault area of the Moon as imaged by Walter Elias (AEA) on 2019 Jul 05 UT 22:23 and orientated with north towards the top. Inset shows a contrast enhanced view of the crater.

I have enhanced the interior of the crater in the inset in Fig 1 and can see a possible illuminated area in the shadow which is either due to scattered light off the rim reaching the shadow filled floor or topography starting to break through the shadow into sunlight. I think therefore we shall reduce the ALPO/BAA weight down to 0 and remove it from the database.

Pytheas: On 2019 Jul 12 UT01:50-02:05 Jay Albert observed visually this crater, and Jairo Chavez (SLA) imaged, under similar illumination and topocentric libration (to within ±1.0°) to the following report:

On 1982 Jul 01 at UT 02:23-02:58 Robotham (Springfield, ON, Canada, seeing=II) found that the west rim of Pytheas crater was a very bright yellow-white, indeed brighter than Proclus. At lower magnifications, Pytheas was one of the brightest spots on the Moon. The Cameron 2006 catalog ID=173 and weight=2. ALPO/BAA weight=2.

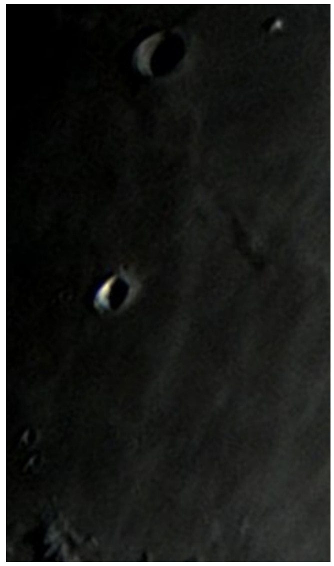


Figure 2. Pytheas as imaged in color by Jairo Chavez (SLA) on 2019 Jul 12 UT 03:04 and orientated with north towards the top. Taken with a 10” reflector.

Jay found that the crater’s western wall was indeed very bright with an intensely bright, white spot in the center of the west wall. Certainly, at a magnification of x51 the crater appeared visually as one of the brightest features on the Moon. This concurs with the original LTP description. Jay notes that the west wall was brighter than the west wall of Copernicus. A slight yellowish tint was noted at the crater, but also over the entire Moon due to the haze and thin clouds. Jay used magnifications of 51x and 290x on his Celestron NexStar Evolution 8” SCT. The waxing 75% lit Moon was high in the south. The sky was very hazy with thin stratus clouds almost everywhere. Transparency was initially 1st magnitude where clear, but deteriorated gradually throughout the session until only Jupiter and the Moon were visible. Seeing was 7/10 except for image motion when clouds passed. No filters were used. In Jario’s image in Fig 2, we see not only, that the crater is bright, but indeed there is a yellowish cast on the brightest part of the west rim – though this turns out not to be due to natural surface color, but possibly chromatic aberration or atmospheric spectral dispersion, as the effect is visible elsewhere (outside the area shown in Fig 2). In view of these two observations, I will lower the weight from 2 to 0 and remove this 1982 LTP from the system as we have shown how the brightness and color can occur.

Aristarchus: On 2019 Jul 16 UT 22:58 Walter Latrónico (AEA) imaged the crater during the lunar eclipse, under similar illumination and topocentric libration (to within ±1.0°) to the following reports:

On 1978 Sep 16 at UT19:30 R. McKim (Colchester, Essex, UK, 216mm reflector and binoculars) observed that Aristarchus, in the lighter region, during the lunar eclipse, was duller than usual but no less conspicuous than expected. The Cameron 2006 catalog ID=38 and weight=5. The ALPO/BAA weight=1.

On 1982 Jan 09 at UT18:46-21:42 P. Moore, (Selsey, UK) and others found that Aristarchus and Plato changed in brightness and color during a lunar eclipse. Aristarchus was especially bright during the lunar eclipse. Cameron 2006 catalog ID=162 and weight=5. ALPO/BAA weight=3.

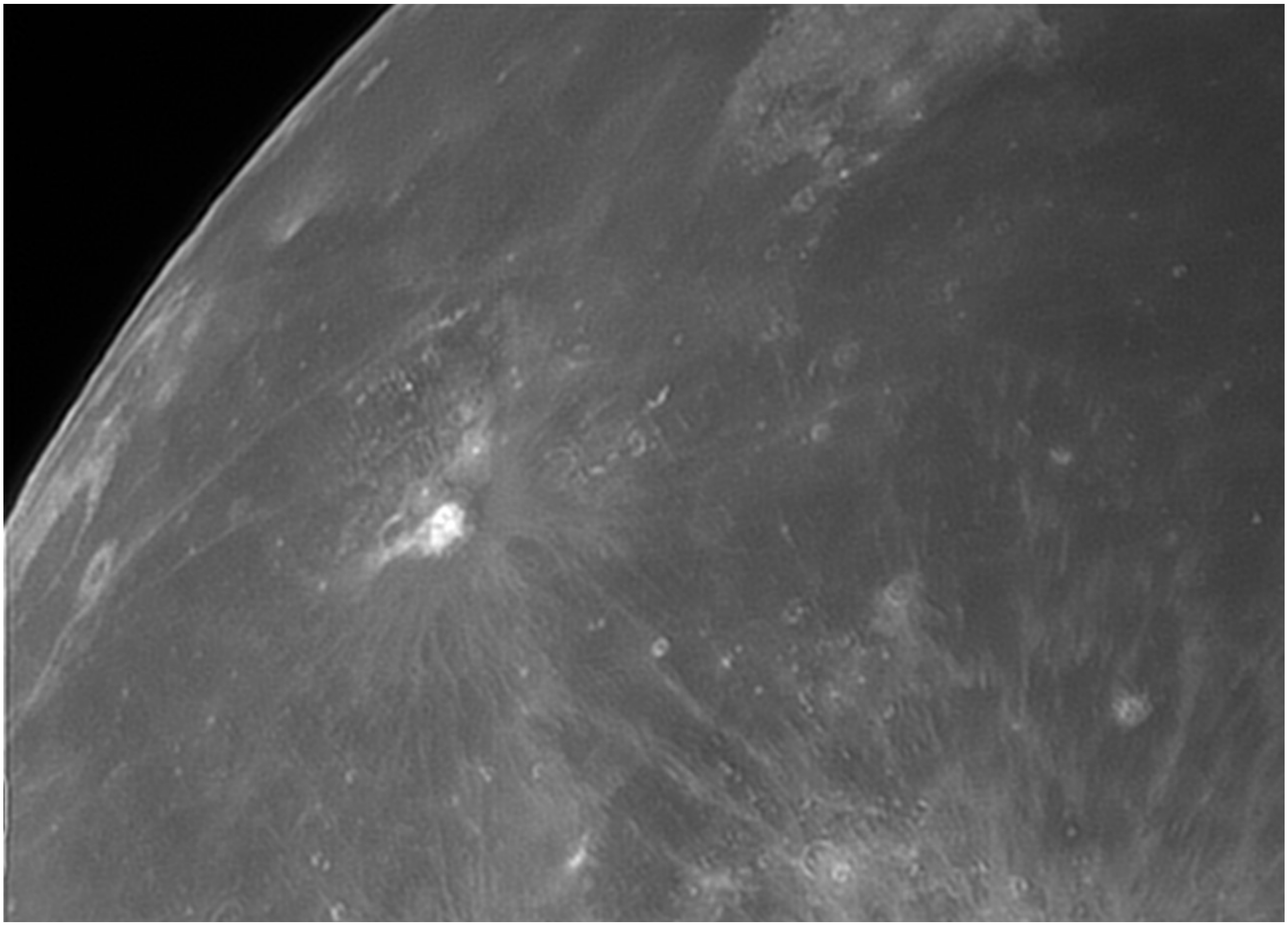


Figure 3. Aristarchus in the penumbral part of the Moon during the Lunar Eclipse on 2019 Jul 16 UT 22:58 as imaged by Walter Latrónico (AEA). Orientated with north towards the top.

Although Walter's image (Fig 3) corresponds to similar illumination and viewing angle to the above two mentioned LTP reports during eclipses, only the 1978 report has some relevance as it describes Aristarchus as being in the lighter region (penumbra?) which was a similar stage in the eclipse that Walter had imaged. In terms of the brightness of Aristarchus it certainly cannot be described as duller than usual – although I would agree with the description: "no less conspicuous than expected". I am also interested in the lineated grid-like structure in the plateau area to the N/W of Aristarchus as I do not recall seeing this before. For the 1982 report there is not a lot we can add in re-interpreting this as we would need a time sequence. I'll leave the weights of the reports at 1 & 3 respectively for now.

Schmidt: On 2019 Jul 16 UT 22:58 Avril Micaela Elias (AEA) imaged this region under similar illumination and topocentric libration (to within ±1.0°) to the following report:

On 1982 Jan 09 at UT 18:46-21:42 M. Mobberley (UK) observed that Schmidt was very bright compared to its surroundings during a total lunar eclipse. Cameron 2006 catalog ID=162 and weight=5. ALPO/BAA weight=2.

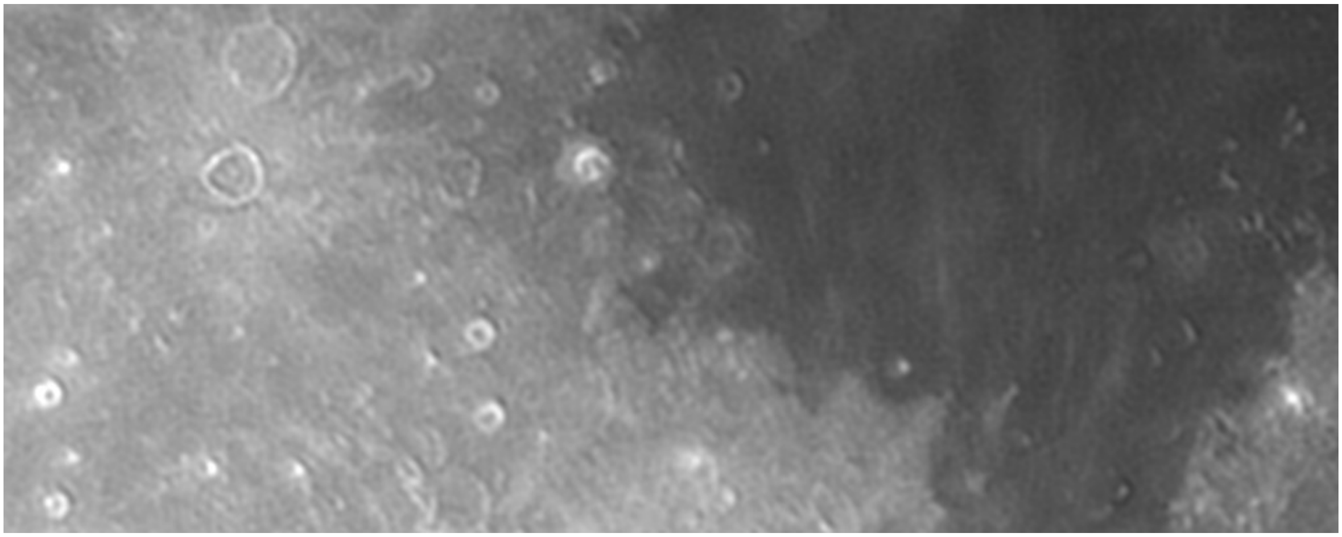


Figure 4. The small 11 km diameter Schmidt crater at the center of the image, taken by Avril Micaela Elias (AEA) on 2019 Jul 16 UT 22:58 in the penumbral shadow of the eclipse. Image orientated with north towards the top.

From looking at Fig 4, it is quite clear that Schmidt is pretty indistinct compared to its surrounds, although is out of the umbral phase of the eclipse at this point. I have checked Martin Mobberley's photos that we have in the archive and none of these show Schmidt as being very bright – only Dionysius and that appeared as bright as normal. Martin does not discuss Schmidt in his observing report from the next day. There is though a mention of the report on p4 of the 1982 Mar BAA Lunar Section Circular, where he states that both Schmidt and Censorinus were very bright relative to their surrounding at 18:08 during the eclipse. I shall leave the weight at 2 for now as Avril's image differs to the Mobberley description.

Promontorium Fresnel: On 2019 Jul 16 UT 23:08 Facundo Gramer (AEA) imaged this region under similar illumination and topocentric libration (to within ±1.0°) to the following report:

On 1982 Jan 09 at UT 18:46-21:42 some unknown British observers saw a glow near Promontorium Fresnel during a lunar eclipse. The Cameron 2006 catalog ID=162 and weight=5. The ALPO/BAA weight=2.

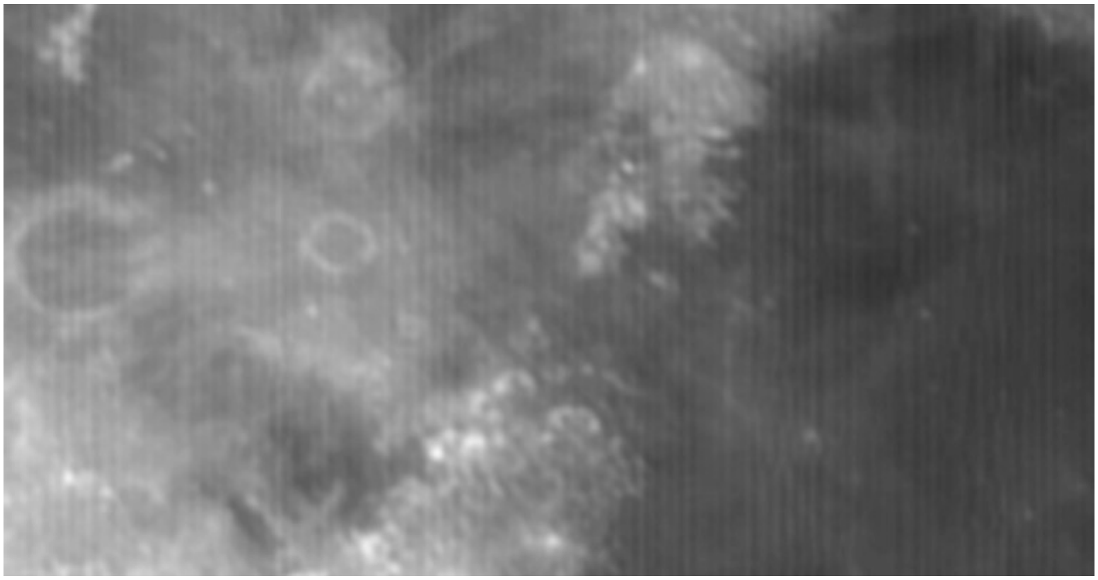


Figure 5. Promontorium Fresnel located just below the center of the image taken by Facundo Gramer (AEA) on 2019 Jul 16 UT 23:08 and orientated with north towards the top. Stripes in the image are an imaging artefact.

A quick look through the BAA Lunar Section Circular (1982 Mar edition – p3), reveals that the unknown observer was Andy Hollis, of Northwitch, UK, who described a glow near Promontorium Fresnel, but no time is quoted. Clearly there is no glow appearance in Fig 5, so we shall leave the weight at 2 for now.

Picard: On 2019 Jul 16 UT 23:02 Cian Gonzalez (AEA) imaged this crater under similar illumination and topocentric libration (to within ±1°) to the following report:

On 1927 Dec 08 at 20:00 Bogdanovich (Russia) Picard: "Crater, after coming out of shadow after ech. was unusually hazy. next FM it was back to normal". The Cameron 1978 catalog ID= and weight=3. The ALPO/BAA weight=2.

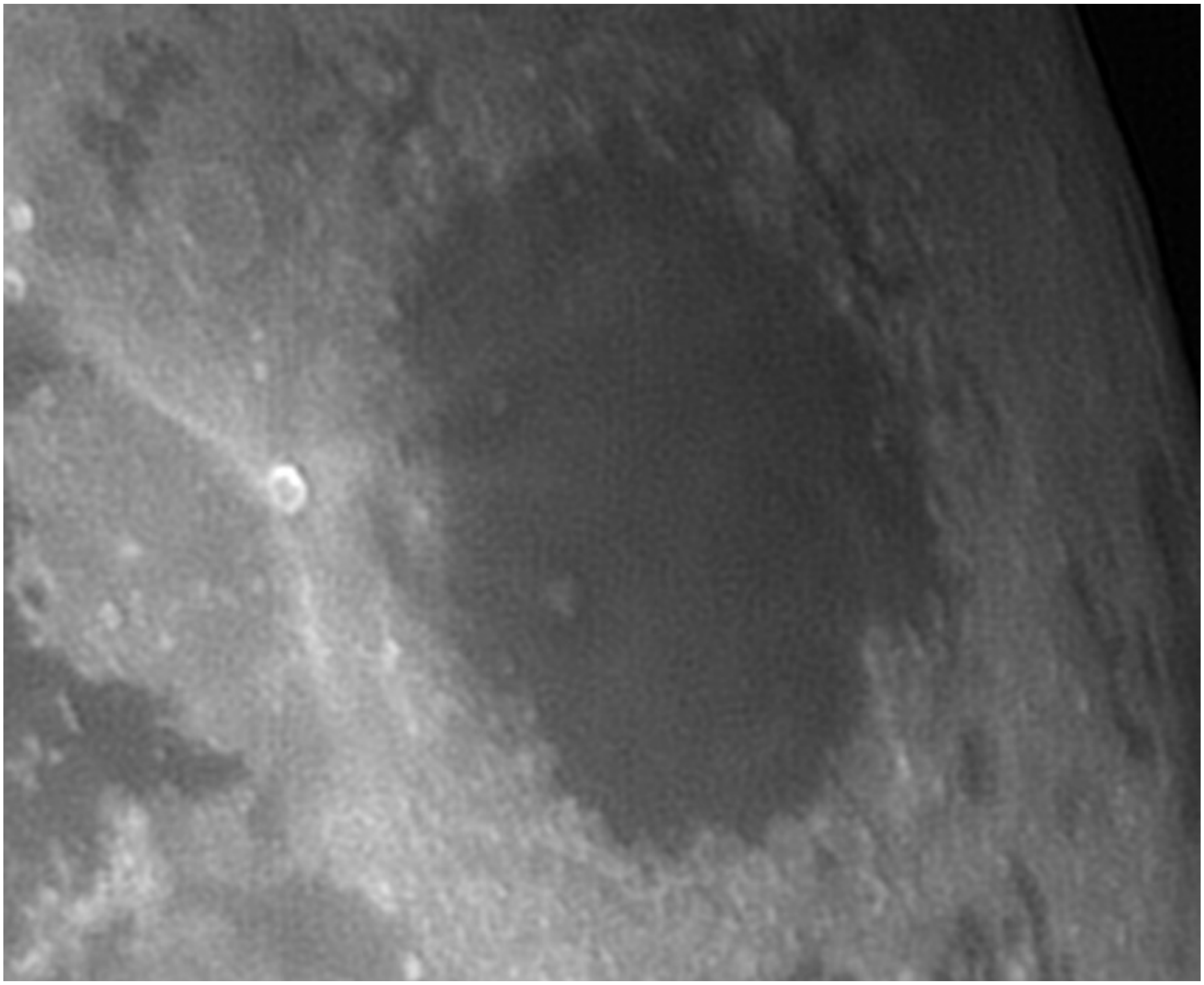


Figure 6. Image of Mare Crisium, taken on 2019 Jul 16 UT 23:02 by Cian Gonzalez (AEA) and orientated with north towards the top.

Fig 6 certainly shows Picard as a bit hazy in appearance, though whether this was more so than normal is uncertain. Bogdanovich mentions that it was back to normal at the next Full Moon. I think we shall lower the weight to 1 for now. Incidentally Fig 6 shows the shadow on the east side of some features effect mentioned in last month's newsletter – I still feel that this is probably an image stacking issue with respect to the moving eclipse shadow.

Plato: On 2019 Jul 16 UT 23:06 Alan Trumper (AEA) imaged this crater under similar illumination and topocentric libration (to within ±1°) to a Patrick Moore report from 1982:

On 1982 Jan 09 at UT21:37 P. Moore (Selsey, UK) observed that Plato underwent brightness and color changes, during a total lunar eclipse. At 20:07UT Madej observed a "slight anomaly in Plato". Cameron 2006 catalog ID=162 and weight=5. ALPO/BAA weight=3.

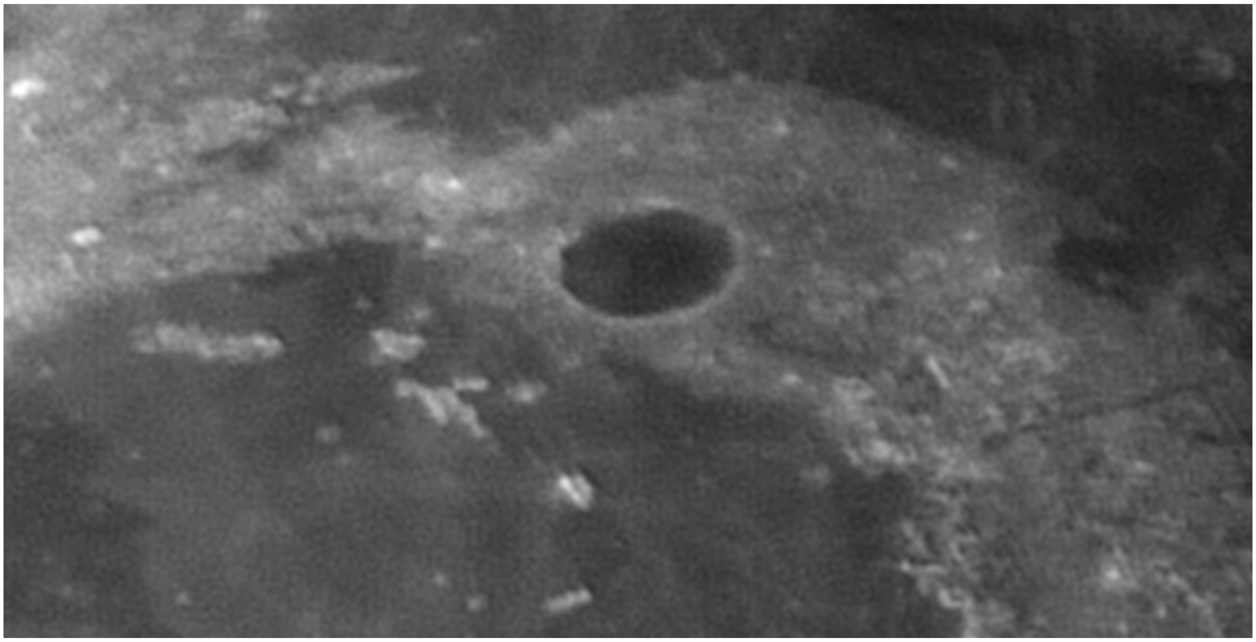


Figure 7. Image of Mare Plato, taken on 2019 Jul 16 UT 23:06 by Alan Trumper (AEA) and orientated with north towards the top.

Although we cannot see from Alan's image (Fig 7) whether brightness or color variations took place on this eclipse, at least we have a general appearance of what Plato should normally look like in the penumbra – for future reference. Again, we can see shadow effects on the NE corners of some high topography which might be related to image stacking artefacts as the penumbral shadow moves across the lunar surface. We shall keep the weight at 3 for now.

Mare Fecunditatis: On 2019 Jul 16 UT 23:47 Valerio Fontani (UAI) imaged the partial lunar eclipse under a similar selenographic colongitude to the following Lunar Schedule web site report:

On 2000 Jan 21 UT04:40 G. Emersen (Golden, CO, USA, 30cm focal length lens with Wratten 25 ref filter) took 43 CCD images of the eclipse of the Moon and on one of them at 04:40UT (exposure 0.3 sec) a relatively bright spot appeared in the southern part of Mare Fecunditatis. The spot looks sharper than the rest of the Moon and so might be a cosmic ray? CCD images taken from Washington D.C. by A.C. Cook at this time, do not show this spot, however exposures were at intervals of 0.25 sec and so might have missed this spot if it happened during image readout. The ALPO/BAA weight=1.

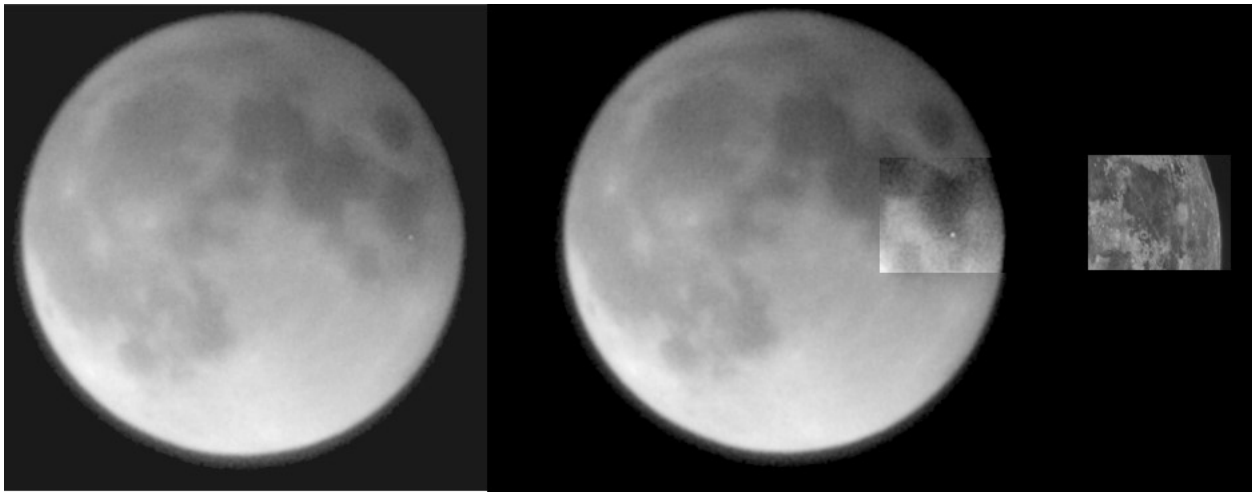


Figure 8. The lunar disk orientated with north towards the top. **(Left)** an image by G. Emerson taken on 2000 Jan 21 UT 04:40. **(Center)** The same image but with a region in Mare Fecunditatis showing a transient point highlighted. **(Right)** A resolution degraded version of an image by Valerio Fontani, taken on 2019 Jul 16 at UT 23:47.

The lunar schedule web site had the request for this similar selenographic colongitude observation as we wanted to know if there were any small-scale ray craters or features that could resemble a bright point under low resolution. Although the bright point that G. Emerson imaged (Fig 8 – Left and Center) was not on previous images, it could be that this was the least motion shaken image obtained and perhaps it was a bright crater? Valerio's image (Fig 8 – Right) shows that there is no albedo feature on the Moon in this part of the mare that could produce this effect. Therefore, what was captured in 2000 was almost certainly a cosmic ray event in the camera, though there is always a very slight chance that it could have been an impact flash – but as it was not confirmed, we will perhaps never know for sure. We can now remove this request from the lunar schedule website as it cannot be solved by taking any more images.

Aristarchus: On 2019 Jul 17 UT 00:17 Roman Garcia Verdier (LSA) imaged the regional area around this crater under similar illumination to the following report:

On 1961 Aug 26 at UT 01:25-01:41 Chernov (Russia, 6x binoculars) found that during a penumbral phase of an eclipse Aristarchus appeared as a bright white point easily seen in 6x binoculars. At the same time the fissure near Aristarchus and Herodotus. (Schroter's Valley?) could be seen, but not easily. The Cameron 1978 catalog ID=746 and weight=2. The ALPO/BAA weight=1.

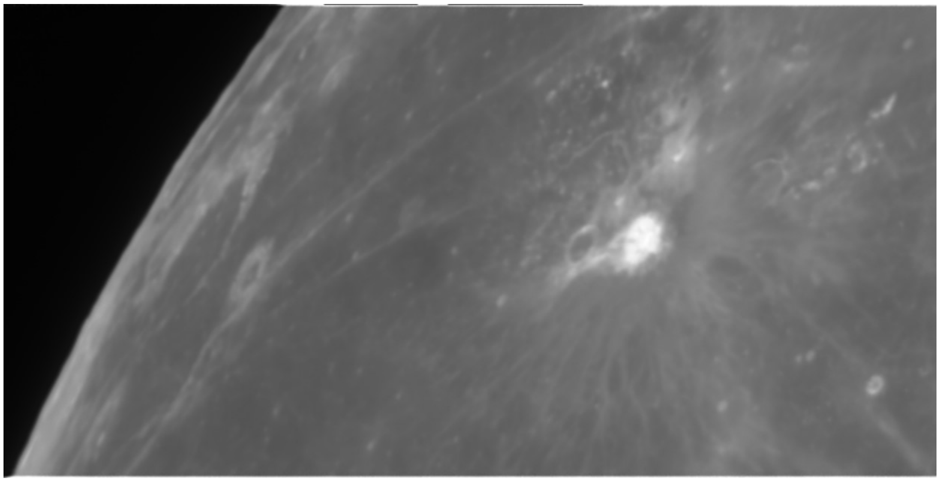


Figure 9. The Aristarchus area as imaged by Roman Garcia Verdier (SLA) on 2019 Jul 17 UT 00:17 and orientated with north towards the top.

Although there were several repeat illumination events, this one corresponded to the penumbral stage of the eclipse. As you can see in Roman's image (Fig 9), Aristarchus is certainly bright and at a lower magnification, would appear as a white point. The piece about "*the fissure near Aristarchus and Herodotus. (Schroter's Valley?) could be seen, but not easily"* is certainly true in Roman's image, and I would have imagined that it would have been even more difficult to see in such a small instrument as Chernov was using. I do not think this report should have ended up in the NASA catalog in the first place, with the size of the aperture used – we shall therefore lower the weight to 0 and remove it from the ALPO/BAA catalog.

Torricelli B: On 2019 Jul 19 UT 22:26 Franco Taccogna (UAI) imaged the area around this crater under similar selenographic colongitude to the following report:

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

Figure 10. Torricelli B is just left of the image center with north towards the top. Image by Franco Taccogna (UAI) taken on 2019 Jul 19 UT 22:12. **(Left)** Original image with color saturation increased to 50%. **(Right)** Image blurred using a Gaussian filter of radius 1.

In Fig 10 (Left) we can quite clearly see a shadow in Torricelli B, and Fig 10 (Right) shows what the crater would look like if the seeing gets bad, namely hazy. So what Clive Brook described was perfectly normal. We can therefore safely remove this from the ALPO/BAA LTP database by assigning a weight of 0.

Copernicus: On 2019 Jul 21 UT David Scanlan (Baddesley, UK – BAA) imaged the Moon under similar illumination and topocentric libration (to within ±1°) to the following report from the Soviet Union:

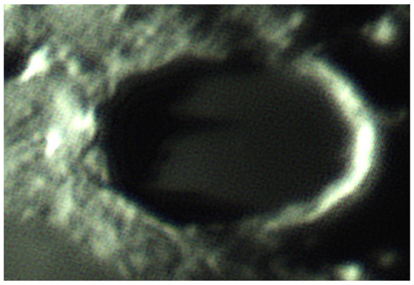
On 1977 Oct 31 UT 05:03 V.M. Chernov (Soviet Union) observed that Copernicus was brighter than normal i.e. brighter than Kepler. It was though slightly less bright than it had been on during the Oct 28th LTP. The ALPO/BAA weight=1.

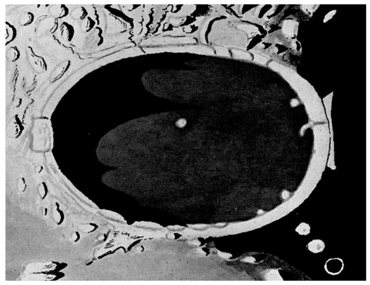
Now being under effectively the same illumination and viewing angles we should in theory expect to see the same result again in Dave's image in Fig 11. Indeed, Copernicus looks visually to be brighter than Kepler, but to be sure I took some digital number readings direct from Dave's image and this gives: Kepler=206, Copernicus=209. So, we can safely remove this LTP from the catalog by assigning a weight of 0.

Figure 11. An image of the whole Moon taken by David Scanlan (BAA) on 2019 Jul 21 UT 00:46 using a Meade 8” scope. Orientated with north just slightly to the left of top.

Plato: On 2019 Jul 25 Thierry Speth (BAA) and Maurizio Cecchini (UAI) imaged Plato under similar illumination to the following report from 1944:

On 1944 Aug 12 at UT 04:00 H.P. Wilkins (Kent, UK, 8.52" reflector) observed that central craterlet in Plato was unusually bright and shows up as a bright white spot on his sketch - though this might have been artistic license on his part. His written notes refer to the unusual lack of a rim (especially the northern part) to this craterlet. The ALPO/BAA weight=2.





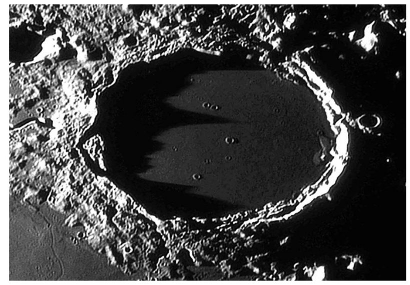
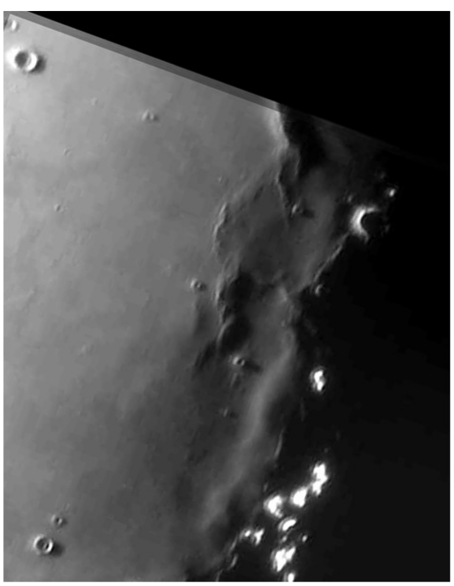


Figure 12. Plato orientated with north towards the top. **(Left)** Color image by Thierry Speth (BAA) taken on 2019 Jul 25 UT 01:53. **(Center)** A sketch by H.P. Wilkins from 1944 Aug 12 UT 04:00. **(Right)** Image by Maurizio and Francesca Cecchini (UAI) taken on 2019 Jul 25 UT 02:12.

As you can see from the images (Fig 12) by Thierry Speth, Maurizio and Francesca Cecchini, there are some inaccuracies in the Wilkins sketch – though the main point is that the central craterlet should not have been as bright as Wilkins drew. You will note that Wilkins did not draw the bright craterlet as being central, but if we use the shadow on the floor of Plato as a reference, it is quite clear that this white spot should have been near the center of Plato. I think that I will leave the weight at 2 for now as it does not merit a 3 due to the cartographic inaccuracies.

Montes Spitzbergen: On 2019 Jul 25 Aldo Tonon (UAI), Maurizio and Francesco Cecchini (UAI), and other UAI observers imaged this area due to a request on the Lunar Schedule web site:

ALPO Request: please image or sketch the area to the east and north west of this group of mountains. We are attempting to study some wrinkle ridges here, and in particular trying to see if there is a very low lying (previously unknown) valley in the mare here.



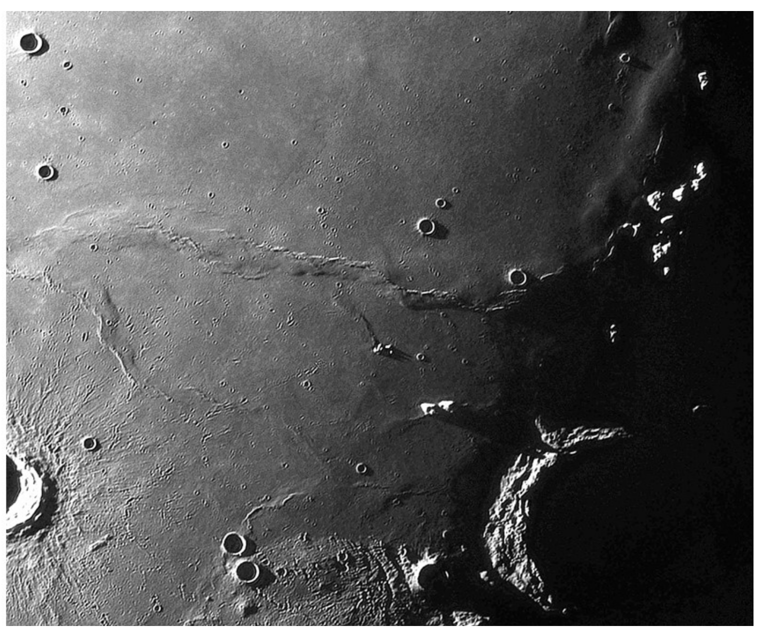


Fig 13. Region N/NW of Montes Spitzbergen on 2019 Jul 25 and orientated with north towards the top. **(Left)** Image by Aldo Tonon (UAI) at 01:41UT. **(Right)** Image by taken at 02:03UT by Maurizio and Francesco Cecchini (UAI).

From figure 13 it is starting to look like the underlying lava flooded crater chain theory for this features flawed as I don't see too much evidence for raised rims and if craters were there under the mare then why would they appear to be of increasing or decreasing size along the length of the valley – this is not normal for large crater chains. So more likely it is a couple of flow lava flow fronts or wrinkle ridges. Its probably best if we drop this from the LGC newsletter as its not really in our remit to study geological features unless they have evidence of recent change i.e. LTP reports, geologically recent areas, or known lunar shallow seismic sites.

Montes Teneriffe: On 2019 Jul 25 UT 03:03 Maurizio and Francesco Cecchini (UAI) imaged this area (Fig 14) using the Lunar Schedule website to confirm the presence of a lunar dome here. This request for images has been running for a while now. Other images for that night were supplied by other UAI observers and Thierry Speth. The dome was visible from at least 02:07UT to probably after 07:25UT as it was seen in an image by seen in an image by Bruno Cantarella (UAI) – not shown here. The dome has now been extensively described in a paper by Maurizio Cecchini in the Italian journal: Astronomia, No. 4, Jul-Sep, 2019, p24-28, and so we can now remove the request for further observations from the Lunar Schedule web site.

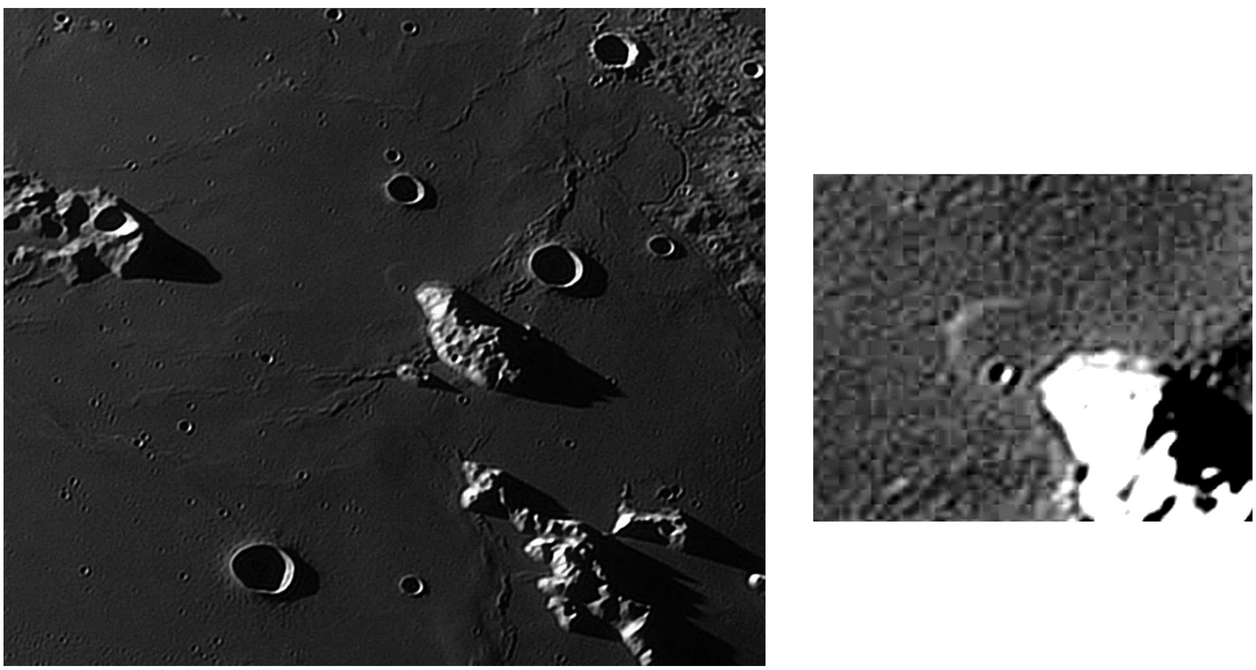


Figure 14. (Left) A lunar dome "Ten 1" or "Teneriffe 1" as imaged by Maurizio and Francesco Cecchini (UAI) on 2019 Jul 25 UT 03:03. **(Right)** An enlarged and contrast stretched view of the dome.

"Ten 1" does not show up well in the NASA LROC images (Fig 15), though Maurizio's paper does show a nice topographic cross section through the NASA LRO LOLA laser altimeter dataset. I was interested though in something which skirts around the base of the Teneriffe mountain peak – could this be a lobate scarp or a topographic manifestation of the wrinkle ridge to the south showing up in mass wasting from the mountain slopes? It is quite a sharp structure, so might be geologically recent? I will leave it to the lunar geology experts in the section to decide amongst themselves.

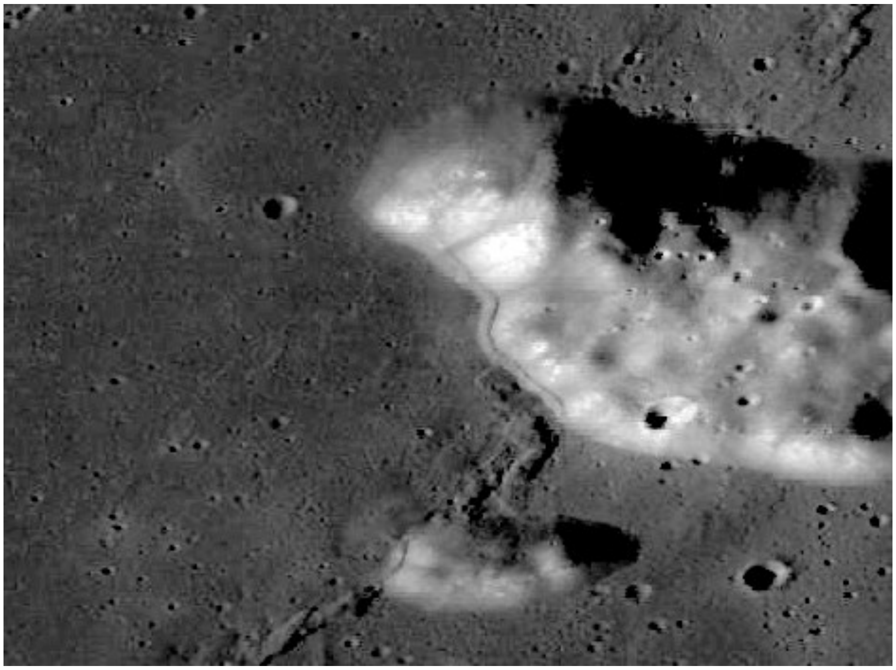


Figure 15. A closeup and contrast stretched version of the NASA Quick Map WAC mosaic which just about shows "Ten 1" near the top left.

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: Atlas & Copernicus

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 **November 2019** edition will be the Atlas & Hercules 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

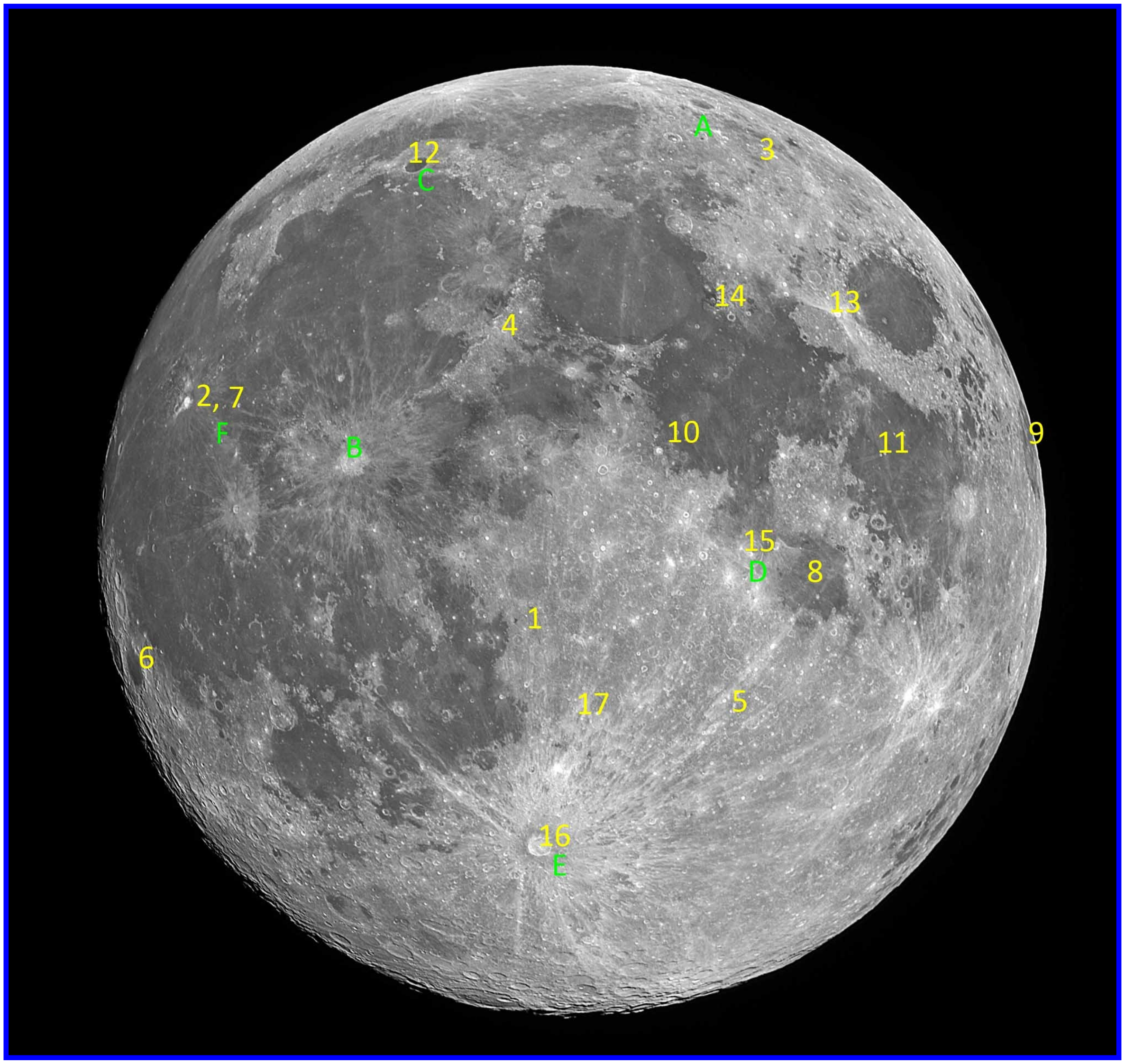
Deadline for inclusion in the Atlas and Copernicus region article is October. 20, 2019

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
Atlas & Copernicus	November 2019	October 20 ,2019
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. **Burg**
4. **Conon**
5. **Gemma Frisius**
6. **Grimaldi**
7. **Herodotus**
8. **Mare Nectaris**
9. **Mare Smythii**
10. **Menalaus**
11. **Messier**
12. **Plato**
13. **Proclus**
14. **Taurus Littrow**
15. **Theophilus**
16. **Tycho**
17. **Werner**

Upcoming Focus-On targets:

A. Atlas
B. Copernicus
C. Plato
D. Theophilus
E. Tycho
F. Herodotus