The Lunar Observer

A Publication of the Lunar Section of ALPO

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August 2022

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Online readers, click on images for hyperlinks

Lunar Reflections

Many thanks to all who contributed to this issue of *The Lunar Observer*! As I put the finishing touches on this August 2022 issue, I am again amazed by all of the high quality lunar observations from across the world. This issue contains tours of the lunar terminator by Guillermo Scheidereiter, a look at the topography of wrinkle ridges, the craters Bessarion and Bessarion E and a ghost crater near Kepler by Alberto Anunziato, a study of a new rille system near Linné by Raffaello Lena and KC Pau, domes near Rupes Recta by Rik Hill and for the ninth in his series, Darryl Wilson enlightens us on more lunar imaging techniques. All this plus amazing lunar drawings and images from across the planet. Tony Cook continues to study Lunar Geologic Change and also Buried Basin and Craters.

Speaking of Basins, the virtual ALPO conference on July 22-23, 2022 featured much about the organization including three talks about the Moon. The keynote talk was by Charles Wood about how lunar basins affected the entire Moon. If you missed the conference, check it out on the ALPO YouTube channel. I was left very inspired by the knowledge gained!

Please remember to look through your files to find lunar observations of lunar rays in the southern hemisphere. Please send them to Alberto and myself by August 20th. Until then...

Clear skies,
-**David Teske**

Lunar Topographic Studies

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Observations Received

Name	Location and Organization	Image/Article
Alberto Anunziato	Paraná, Argentina	Article and drawing *The Appearance of a Ghost Crater Between Kepler C and Kepler F, Bessarion and Bessarion E* and *The Topography of Wrinkle Ridges.*
Rafael Benavides	Posadas Observatory MPC J53, Córdoba, Spain	Images of Tycho, Clavius and Schickard.
Ioannis (Yannis) A. Bouhras	Athens, Greece	Images of Pythagoras, Schickard and Vallis Schröteri.
Jairo Chavez	Popayán, Colombia	Images of the Waxing Gibbous Moon (4), Waxing Crescent Moon (5), Walter, First Quarter Moon, Hadley(2), Copernicus and the Full Moon.
Maurice Collins	Palmerston North, New Zealand	Images of the 5.1 day old Moon, 7.2 day old Moon, Copernicus (2), Bullialdus, 9.1 day old Moon, 14 day old Moon.
Leonardo Alberto Colombo	Córdoba, Argentina	Image of the Waxing Gibbous Moon.
Massimo Dionisi	Sassari, Italy	Images of Aristillus (2), Piccolomini, Rupes Recta, Arago, Manilius, Hyginus, Gambart, Huxley and Rupes Recta.
Walter Ricardo Elias	AEA, Oro Verde, Argentina	Images of Censorinus, Linné (2), Copernicus, Anaximander, Plato, Proclus, Stevinus and Aris-
István Zoltán Földvári	Budapest, Hungary	Drawings of Rosse, Isidorus and Neper.
Rik Hill	Loudon Observatory, Tucson, Arizona, USA	Article and image *Rupes Recta Domes*.

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

Lunar Topographic Studies

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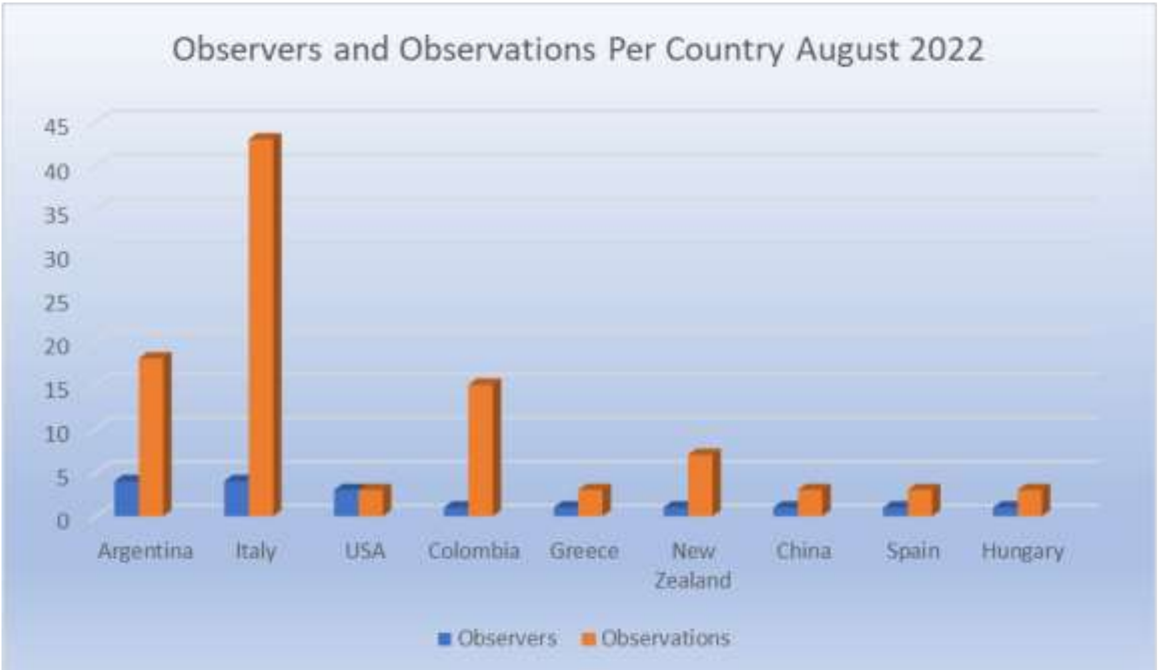
Observations Received

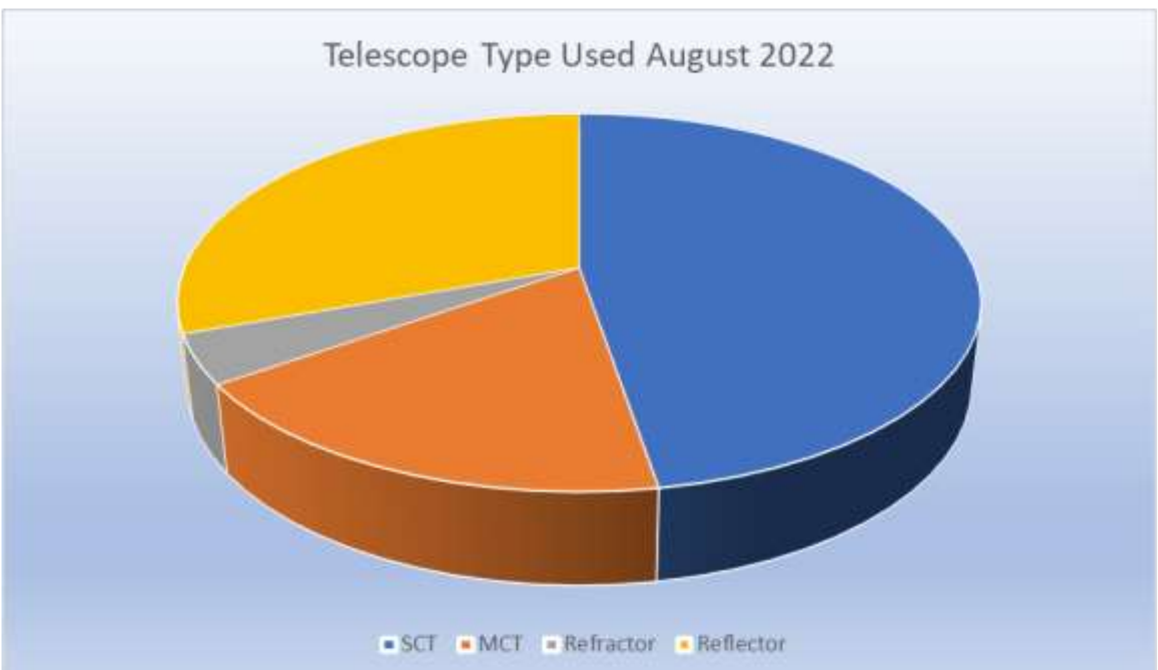
Name	Location and Organization	Image/Article
Raffaello Lena	Rome, Italy	Article *Detection and Identification of Two Rilles South of Linné G Part II*.
Luigi Morrone	Agerola, Italy	Images of Piccolomini, Hercules and Aristoteles.
KC Pau	Hong Kong, China	Article *Detection and Identification of Two Rilles South of Linné G Part II* and images of Wallace (2).
Guillermo Scheidereiter	LIADA, Rural Area, Concordia, Entre Ríos, Argentina	Article *A Walk Along the Lunar Terminator* and images of Eratosthenes, Clavius, Ptolemaeus, Cassini and Tycho.
David Teske	Louisville, Mississippi, USA	Image of the Lunar South Pole.
Fabio Verza	SNdR, Milan, Italy	Images of Aristoteles, Northern Moon, Lacus Mortis, Mare Humorum, Mare Fecunditatis, Plato, Copernicus (2), Tycho, Bullialdus, Clavius, Mare Vaporum, Meton, Montes Caucasus, Sinus Iridum, Montes Apenninus, Catena Sylvester, Hayn (2), Gauss, Mare Humboldtianum, Nansen, Janssen, Lacus Mortis, Endymion, Atlas, Cleomedes, Theophilus and Posidonius.
Darryl Wilson	Marshall, Virginia, USA	Article and images *Use of the Principal Component Transformation to Process Six Bands of Imagery*.

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

August 2022 *The Lunar Observer*
By the Numbers

This month there were 98 observations by 17 contributors in 9 countries.





A Walk Around the Lunar Terminator

Guillermo Daniel Scheidereiter

The Moon of July 7 rose in the sky of the Earth when the Sun said goodbye, and showed a ledge to the naked eye, which motivated my adventurous spirit and sowed intrigue. So, I prepared a modest travel kit: a camera photographic and my Maksutov telescope, a faithful companion on such distant journeys. Dear reader, based on the photographs I took, I can maintain my sanity and confess that what happened next was real.

Clavius, *Guillermo Scheidereiter, LIADA, Rural Area, Concordia, Entre Ríos, Argentina. 2022 July 07 22:34 UT. Explore Scientific 127 mm Maksutov-Cassegrain telescope, IR685 filter, Player One Ceres C camera. North is down, west is right.*

I undertook my trip with the luggage in tow and followed the direction of the highlands of the lunar South, to the ledge, to find that mysterious landscape formed by a multitude of superimposed craters that seem to push each other to gain a better place in the stalls of the universe. And there, emerging from black depths, were Clavius's eyes. Like the face of a ghost, it gazed at the dark surrounding sky; sometimes to me. I felt chills and its 225 km diameter left me breathless; I looked at its wrinkled edges and while the Sun was just beginning to dawn on the terminator, I understood the immeasurability of its time and I was afraid of the deep night that those eyes harbored. My gaze was lost in its three and a half kilometers of vast depth, and I felt overcome with vertigo as I imagined my descent into that mysterious shadow.

Lunar Topographic Studies

Tycho, *Guillermo Scheidereiter, LIADA, Rural Area, Concordia, Entre Ríos, Argentina. 2022 July 07 22:40 UT. Explore Scientific 127 mm Maksutov-Cassegrain telescope, IR685 filter, Player One Ceres C camera. North is down, west is right.*

So it was that I decided to set out for Maginus; I descended more than four kilometers over its rugged slopes until I reached the plains under the warm sun of dawn. I transited the line of its diameter covering 194 km of lunar extension, to emerge between Maginus N and G, and I could see, not so far away, the walls of the young Tycho, like a fortress, enclosing a circular region of 85 km in diameter. I walked through the characteristic confusion of impacts until I reached it, and I witnessed the rays of dawn illuminating its central albedo, while I followed its outline still free from the scourges suffered by its oldest neighbors.

I continued along the guideline that points to the lunar north until I could see to the east a 110 km long wall that broke the plain of what seemed like a phantom crater sunken in the old volcanic wounds of the Moon. So it was that I crossed the gray shores of the Mare Nubium until I reached the great Rupes Recta. I scaled the mysterious wall, leaving Birt and his rhyme behind, and to the northeast of Thebit I could make out, like uneven links in an iron chain, to the craters Arzachel, Alphonsus, and beyond, the great Ptolemaeus.

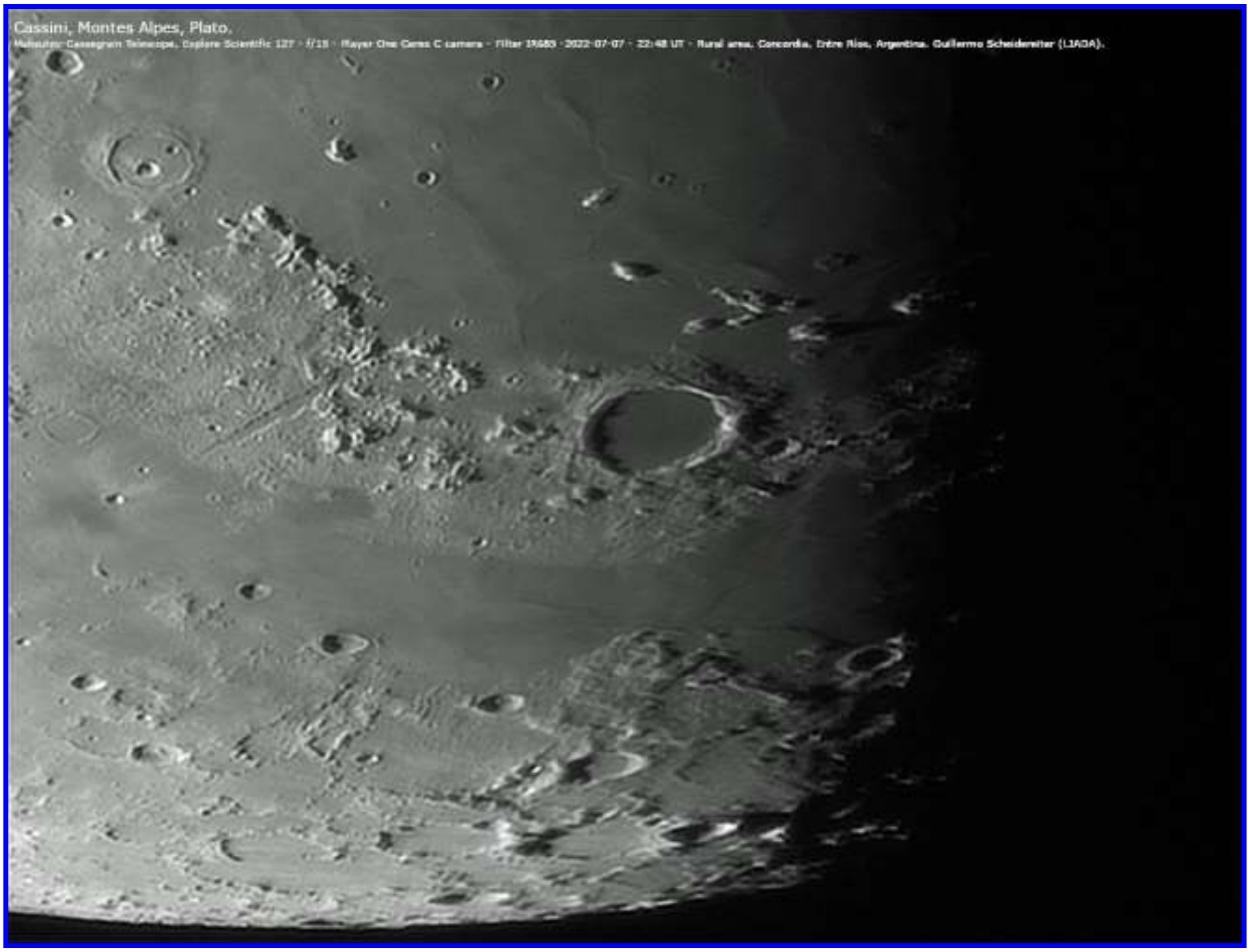
Ptolemaeus, Alphonsus and Arzachel *Guillermo Scheidereiter, LIADA, Rural Area, Concordia, Entre Ríos, Argentina. 2022 July 07 22:55 UT. Explore Scientific 127 mm Maksutov-Cassegrain telescope, IR685 filter, Player One Ceres C camera. North is down, west is right.*

Eratosthenes and Montes Apenninus, *Guillermo Scheidereiter, LIADA, Rural Area, Concordia, Entre Ríos, Argentina. 2022 July 07 22:46 UT. Explore Scientific 127 mm Maksutov-Cassegrain telescope, IR685 filter, Player One Ceres C camera. North is down, west is right.*

From there I went a long way and long after I passed Guericke's rough floor, I sensed the shape of Copernicus in the dark to my left. But fearful of the abysses that enclose the nights, I turned away and crossed the Stadius to reach the top of Eratosthenes. Under the morning light I perceived it as the southern pearl of the Mare Imbrium. As if I were in an ancient tower from the age of the Crusades, from the height of its battlements, my gaze wandered towards the northeast. I marveled at the endless ridges of the Montes Apenninus and imagined the snowy massifs, with pine forests climbing their rocky walls for almost 600 km; the summit of Mons Huygens peeking through the clouds at an altitude of 5,500 m and a river winding through its valleys, eager to spill into Imbrium, while the breaker revealed the edges of Archimedes and his guardians, Aristillus and Autolycus.

There wasn't much to go from there, so, enchanted by the lunar landscape, I continued through the rugged Montes Caucasus that led me to the Cassini crater. From the curb I saw the impacts that its rim encloses and I descended until I reached the lava floor that covers a radial region of 57 km in diameter. Then I traversed the wild Montes Alpes range to its western extreme. A mountain wind chilled my body and behind the clouds, beyond the alpine peaks, I spotted Plato. Almost circular, with a diameter of 100 km, I saw it with the oval shape that causes the effect of foreshortening and I perceived the shadow of the sharp peaks of the parapet, projecting on the landslides, on the shores of a floor with a flat appearance and a dark hue.

Lunar Topographic Studies



Cassini, Montes Alpes and Plato, *Guillermo Scheidereiter, LIADA, Rural Area, Concordia, Entre Ríos, Argentina. 2022 July 07 22:48 UT. Explore Scientific 127 mm Maksutov-Cassegrain telescope, IR685 filter, Player One Ceres C camera. North is down, west is right.*

With my journey drawing to a close, I left behind the brooding gaze of Clavius, the silver sword of a Templar, and the snows that adorned at distant rocky peaks beyond the walls of the medieval lookout. After crossing the bays of the Mare Frigoris, I trudged along the rocky fringes of the lunar surface. And I don't know if it was the reviled Epigenes or the wise Anaxagoras, or a hidden perception of the expanse that lurked ahead, that made me look up at that blue rock lost in the immensity of the night… Amazed as a child, I discovered her errant, alone, bright and vulnerable, floating in space. And I stayed there, enthralled, contemplating for a long time that beautiful planet of enormous continents surrounded by indomitable seas under white storms. Suddenly, the distant clouds closed the sky, the cold winter night breeze hit my face and shook my reverie, and I understood that it was all an illusion, that I was on Earth next to my telescope looking at the Moon.

Lunar Topographic Studies

The Appearance of a Ghost Crater Between Kepler C and Kepler F
Alberto Anunziato

The first impression, at the time of observation, was that this kind of arc of bright points could be a ghost crater. The surroundings of Kepler (which is to the west) are not well known to the amateur due to the fairly homogeneous brightness of the ejecta mantle and the bright rays from this Copernican crater. That is why when the terminator passes so close to Kepler, we see a landscape that we may not see the next night, it is like when we discover the hidden landscape of a river bed when it has temporarily dried up. Visually, a kind of discontinuous arc could be seen, to the south of Kepler C (12 km in diameter), formed by a series of bright spots, clearly high areas reflecting the first lights of the lunar dawn, united to the west (the terminator passes through the west) by two dim parallel lines, which at first, I thought could be the hidden relief of the ghost crater (whose higher reliefs were the brightest areas). But already at the time of drawing, and thinking better, I realized that it was material belonging to mountainous terrain. This can be confirmed with the map of the area extracted from the LROC Quickmap (IMAGE 2). And when observing with less magnification one can perceive that these are peaks that align radially with the most obvious feature, to the north: the Mare Imbrium. It would be ejecta but not from the Kepler crater but from the Mare Imbrium basin. In the shadows near the terminator are two bright spots that we can only identify in IMAGE 1 as the highest points of Kepler D, the older, partially flooded crater, in IMAGE 2. As for the two very bright lines joining the peaks closest to Kepler C with those closest to Kepler F in IMAGE 2 are revealed as two very low parallel elevations.

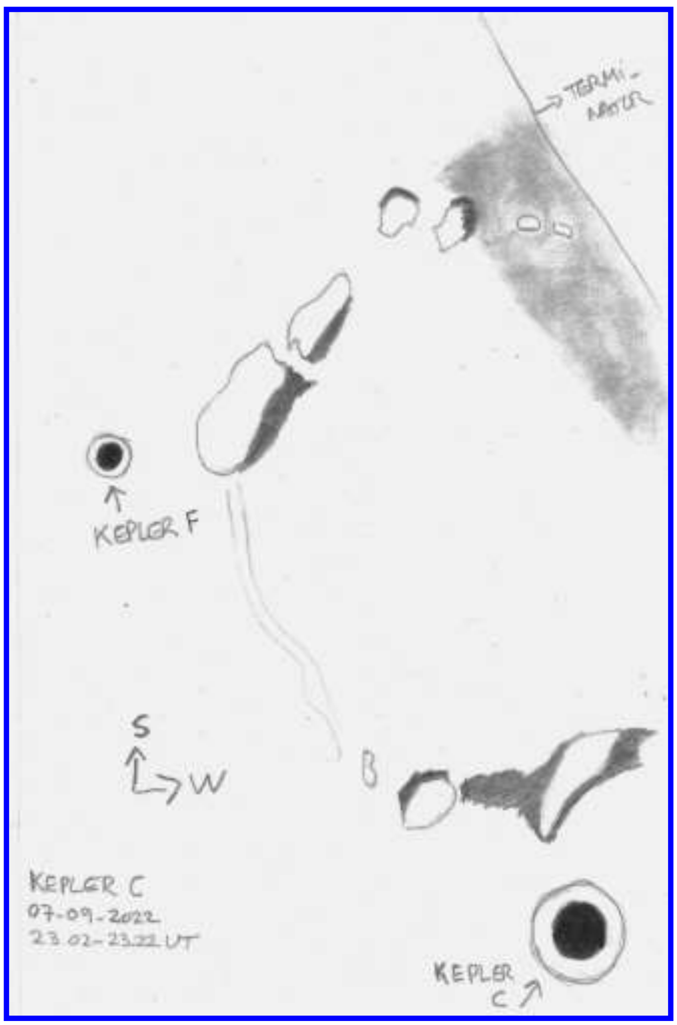


Image 1, Kepler C, *Alberto Anunziato, Paraná, Argentina. 2022 July 07 23:02-23:22 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

Image 2, Kepler C and D, *LROC.*

Lunar Topographic Studies

Bessarion and Bessarion E

Alberto Anunziato

I did not know about the bright ray crater Bessarion until the time of the observation. Bessarion is barely ten kilometers diameter and is obviously a Copernican crater. Obviously because it is a small crater, and yet its rays shine brightly, even when the illumination is very oblique (43.2º colongitude, with the terminator passing very close, in Kepler's ejection field). The impression behind the eyepiece is that they looked like three rays: heading south, west, and east. The northern crater is Bessarion E, 8 kilometers in diameter, and appears to be linked by lightning with Bessarion, Thomas Elger (The Moon, George Philip & son, London, 1895) calls this area, or bright ray, "light area": "Bessarion. A bright little ring-plain, about 6 miles in diameter, in the Oceanus Procellarum N. of Kepler. There is a smaller and still brighter companion on the N. (Bessarion E), standing on a light area. Bessarion has a minute central hill, difficult to detect". The Lunar Orbiter Photographic Atlas of the Moon (David Bowker and J. Kendrick Hughes, NASA, 1971) is old, but there are still images that have not been surpassed by other lunar missions, and this is the case of our Bessarion, IMAGE 2 a detail of Plate 181 (page 230).

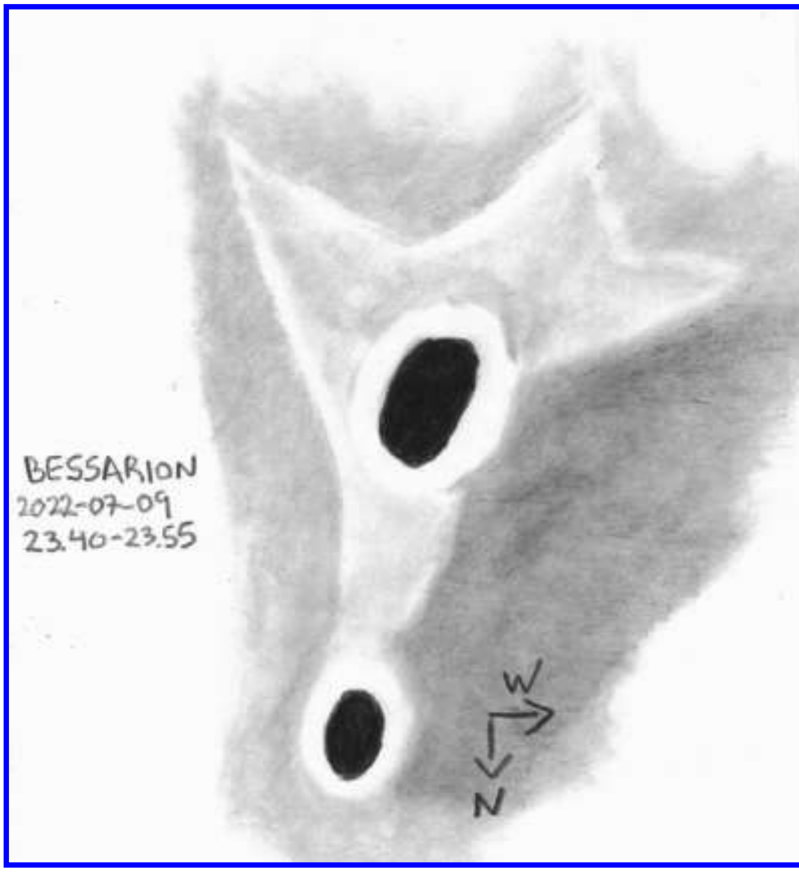
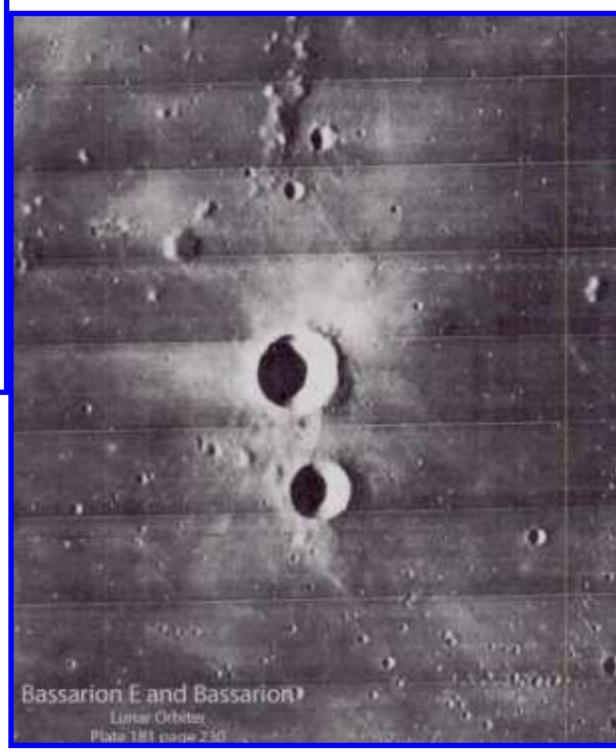


Image 1, Bessarion, *Alberto Anunziato, Paraná, Argentina. 2022 July 09 23:40-23:55 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

Image 2, Bessarion and Bessarion E, *Lunar Orbiter Photographic Atlas of the Moon, plate181 (page 230).*



Lunar Topographic Studies

With oblique illumination and a small telescope like mine, the interiors of both craters appear completely dark. Not only are the bright, short, sharp rays like all those from small craters interesting. The illumination comes from the east, and the zone to the west appeared in shadows and this indicated that both craters were as if united in a higher zone and that the intermediate zone between the two was higher, as if it had been lifted by the impact of the younger crater (may have been either). It's not clear on the drawing (the thinking mind is faster than the drawing hand) but visually it seemed that Bessarion was higher than Bessarion E. I wanted to know if it was a subjective impression, because in these days I have thought a lot about the degree of reliability of visual observation. And the altitude data from the Lunar Orbiter Laser Altimeter of the Lunar Reconnaissance Orbiter Quickmap confirmed the visual impression, look at IMAGE 3, the relief of both craters is very pronounced, and between both craters the terrain is slightly higher than the surrounding ground.

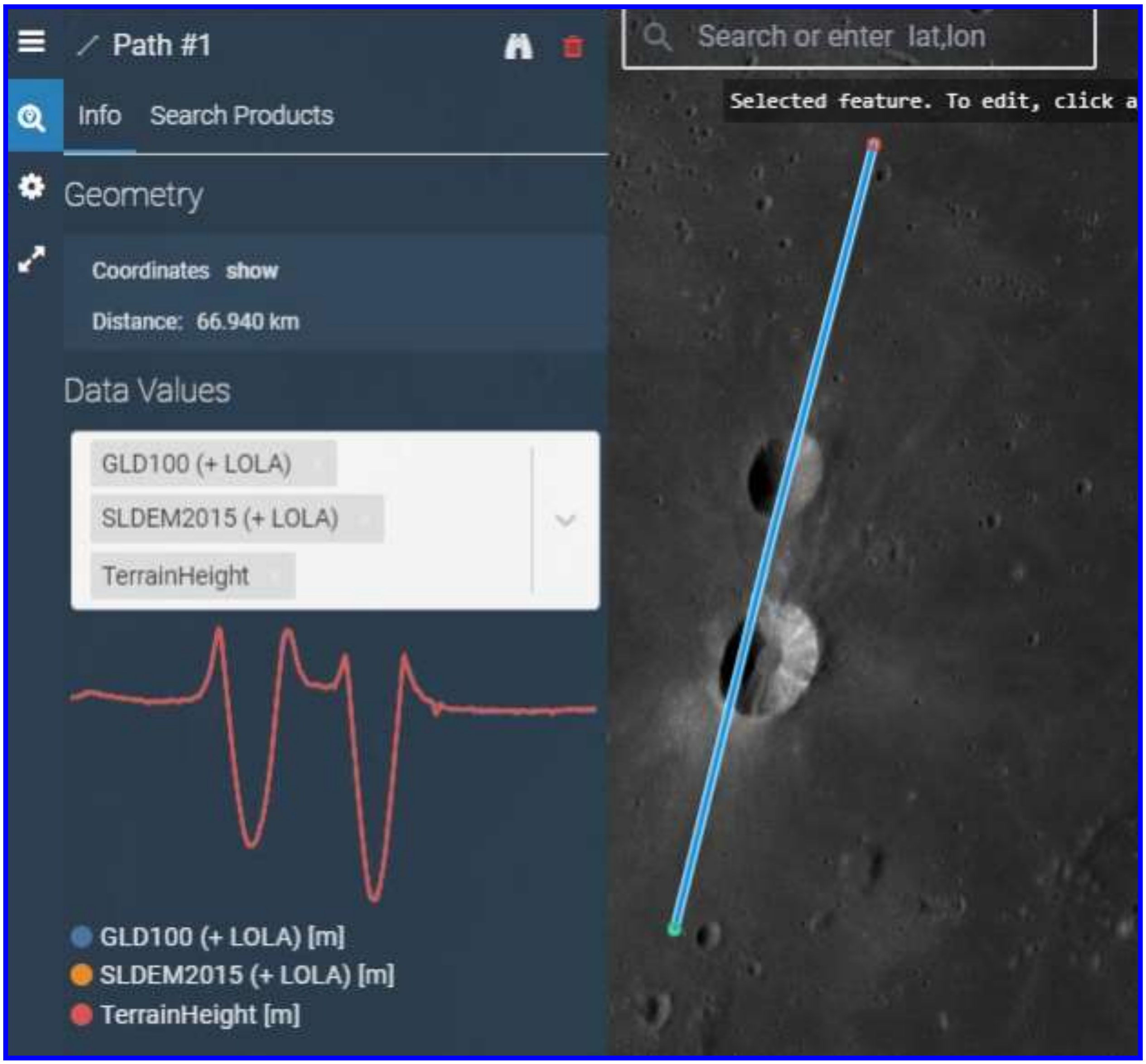


Image 3, Bessarion and Bessarion E, *LROC QuickMap.*

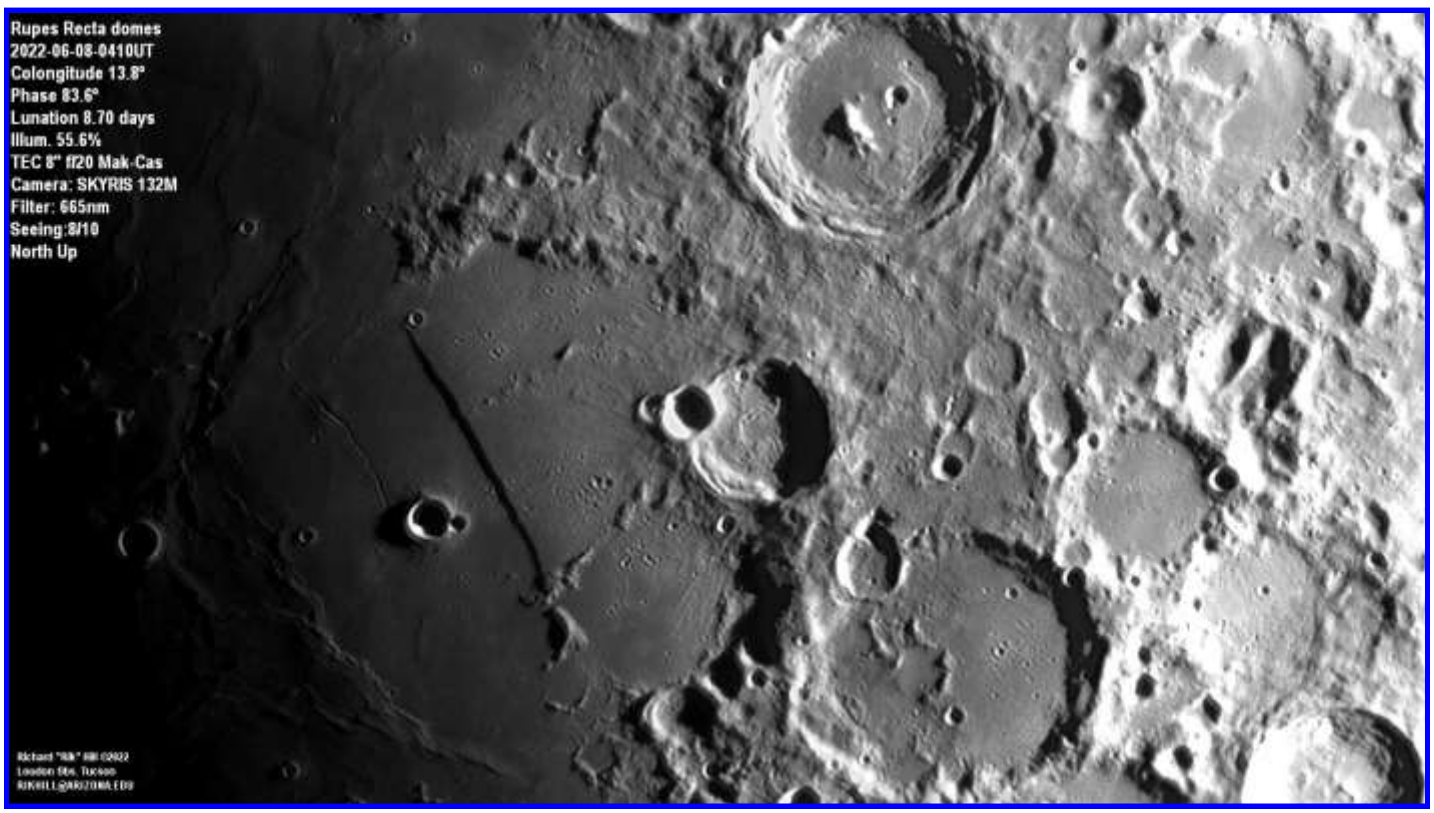
Lunar Topographic Studies

Rupes Recta Domes

Rik Hill

Southwest of the great crater Arzachel (100 km), seen here in the top middle of this image, is the feature called the Straight Wall, or Rupes Recta, a fault running some 114 km. In truth, it is neither straight nor a wall. It is an escarpment some 2-3 km wide with a height of 240-300 m (possibly even 450 m according to Wood) so it is far from the vertical cliff it at first appears. Neither is it straight as can be seen here! At the south end of the Rupes is an interesting set of mountains nicknamed the Stag's Horn Mountains because of their shape. Its not an official name but many lunar observers from the 1950s and 60s are well familiar with them by that name. About 40 km further west is Rima Birt that parallels the Rupes and between the two is the recently formed crater Birt (17 km) overlapped by the even more recent Birt A on the east side. At its north end is another shorter unnamed rima. All this seems to sit in the ruins of an ancient flooded crater some 300 km in diameter. On the east side of this larger structure is the crater Thebit (60 km) and below right, the larger crater Purbach (121 km).

Notice the shadow cast by Birt. There's a mild swelling just beyond and below it. If this is a dome, there is no listing for it. Moving further up the Rupes you get to a point where it widens at the top showing another swelling. This is a recognized dome Birt 1 or B1. Over on the parallel small rima, a little north of this spot is another widening and swelling that is Birt 2. These are among the most difficult domes I have recorded yet but what about the southernmost one? Time will tell.



Rupes Recta Domes, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2022 June 08 04:10 UT, colongitude 13.8°. 8 inch TEC f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 132M camera. Seeing 8/10.*

The Topography of Wrinkle Ridges

Alberto Anunziato

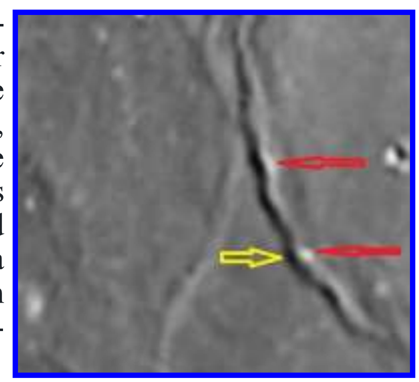
In some previous issue of "The Lunar Observer" we said that "Photographic Lunar Atlas for Lunar Observers" by Kwok C. Pau was the atlas that best graphically represents the topography of the wrinkle ridges. The Atlas, as its name indicates, is clearly oriented towards observation, with images of each feature with different illumination that favors recognition by the observer at the very moment of observation.

Browsing through this atlas with great pleasure, I was marking photographs in which the components of the wrinkle ridges could be seen very clearly. Let us remember that the structure of a wrinkle ridge consists of a wide arch with gentle slopes crowned with a steeper and more irregular crest.

As an observer, I am particularly interested in the relationship between what is observed and what is known about a lunar feature. What we know about the Moon, specifically the topography of the wrinkle ridges, allows us to interpret what we perceive as brights and shadows. Knowing the two components of the wrinkle ridges, I began to notice the smaller features of its structure. Of course, they are very small details, at the limit of the resolution of my 4-inch telescope and only observable near the terminator, rather at the very edge of the terminator. That is why the way is to recognize these characteristics in photographic images, in order to later collate the visual observations and, especially, to be able to recognize them in future observations. For this we chose in the images of Pau of wrinkle ridges, Dorsa Geikie (page 76, Volume 1) and Dorsa Aldrovandi (page 242, Volume 1).

Image 1, Dorsa Geikie. *North is down, west is right.*
Below, Image 2, *close-up of image 1 Dorsa Geikie.*

In IMAGE 1 we see the simplest structure: a narrow wrinkle ridge, especially around the red arrow, in which the crest passes through the center and is distinguished by its brightness and the dark shadows it casts. The brightest areas coincide with the darkest dark shadows, clearly, they are the highest areas of the crest and, therefore, of the entire wrinkle ridge (IMAGE 2, detail of IMAGE 1). IMAGE 3, also a detail of IMAGE 1, shows another structure, a wide arch and the crest running down one side. We see that the arch is not a homogeneous area, there are dark and light areas. The two slopes are different, arrow 1 shows a very gentle slope, while arrow 2 shows a much steeper slope, to the point that there appears to be a second ridge, on the opposite side of the main ridge. IMAGE 4 shows much smaller dorsa in the red circle, which are seen as a mere elevation, although there are slightly brighter areas that would indicate a crest.



Lunar Topographic Studies

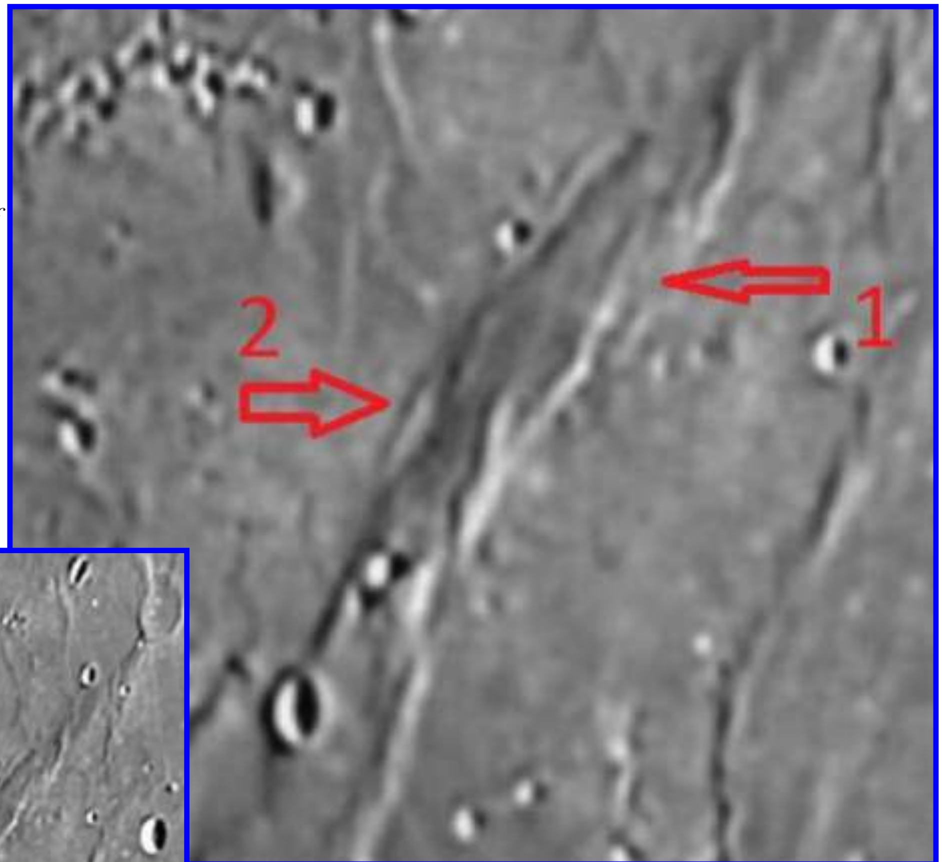


Image 3, Dorsa Geikie. *Close-up of image 1. North is down, west is right.*

Image 4, Dorsa Geikie. *Close-up of image 1. North is down, west is right. This shows a smaller dorsa in the red circle, which are seen as a mere elevation, although there are slightly brighter areas that would indicate a crest.*

Images 1 to 7: Photographic Lunar Atlas for Lunar Observers (Kwok C. Pau)

In IMAGE 5 we see Dorsa Aldrovandi with different illumination, we are going to take advantage of the image on the lower right side, with very oblique illumination, to analyze other possible structures. IMAGE 6 is a detail of IMAGE 5, and shows very little pronounced elevations, similar to those of IMAGE 4, visually we have observed similar wrinkle ridges, although surely, we could not observe the wrinkle ridges shown in this image, we observe more obvious wrinkle ridges with the typologies that we are going to state (while the photographic image reveals details that we do not see visually, such as the crest). We see three types: lower elevations that are perceived as brightness without shadows (arrow 1), they are surely very wide slopes that reflect a lot of light; elevations with brightness and shadow (more typical), marked with the number 2, and with the number 3 elevations that are only perceived as shadows (surely quite rugged, so they have almost no surface that can reflect light). In IMAGE 7 we see a wrinkle ridge with a much more complex structure. The crest passes through the right side at the top and then migrates to the left side at the bottom. We see that not all bright parts cast shadows. The lower arrow shows the area where the crest is highest and casts a deep shadow, most likely a peak. We see in the area between the two arrows how the elevations on the arch are various and complex, as if there were two parallel crests (one higher than the other), the upper arrow indicates a particularly complex area of bright and dark areas, reminiscent, for example, to the intricate topography of Montes Recti, which would indicate that some of the wrinkle ridges are true miniature mountain ranges.

A cartographic question: should we think of a term that names categories such as the highest peak of the crest?

Soon we will deal with the topography of the slopes of the arch of the wrinkle ridges.

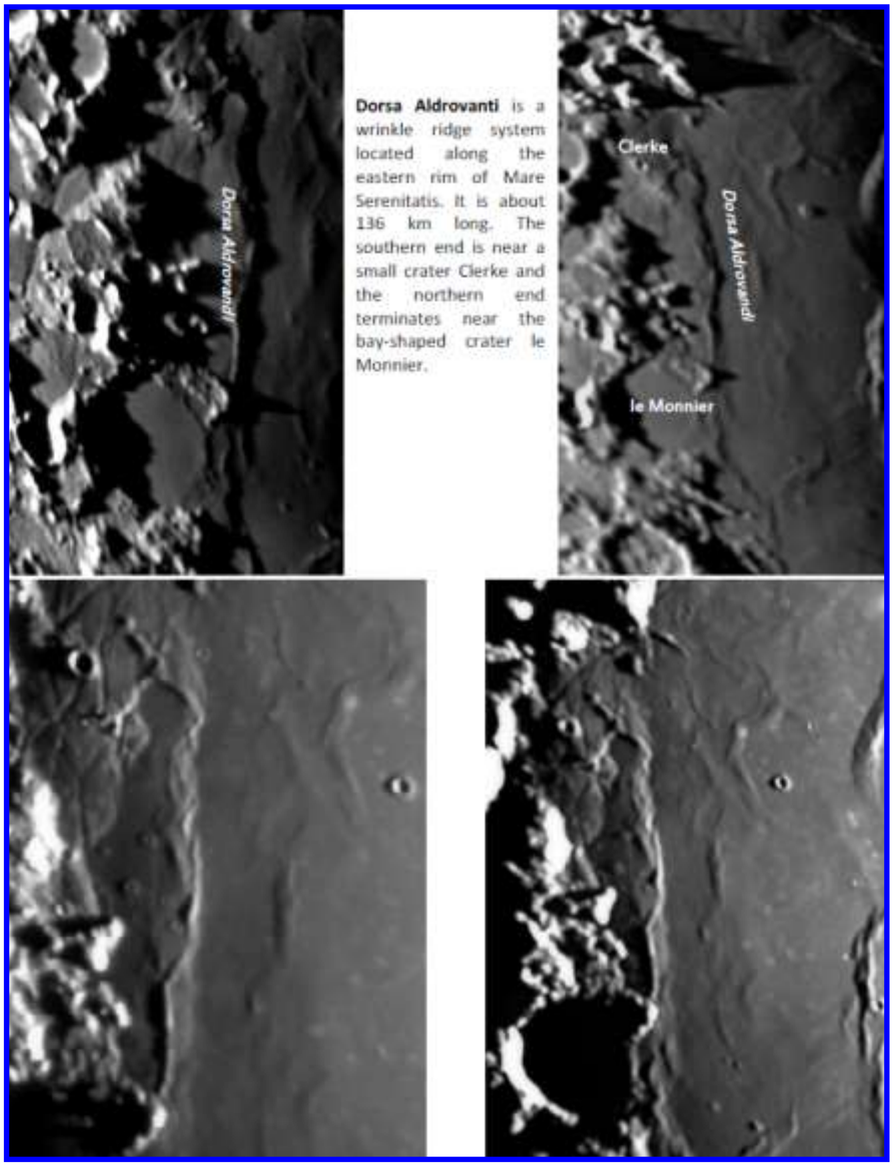


***Image 5, Dorsa Aldrovandi**. North is down, west is right.*

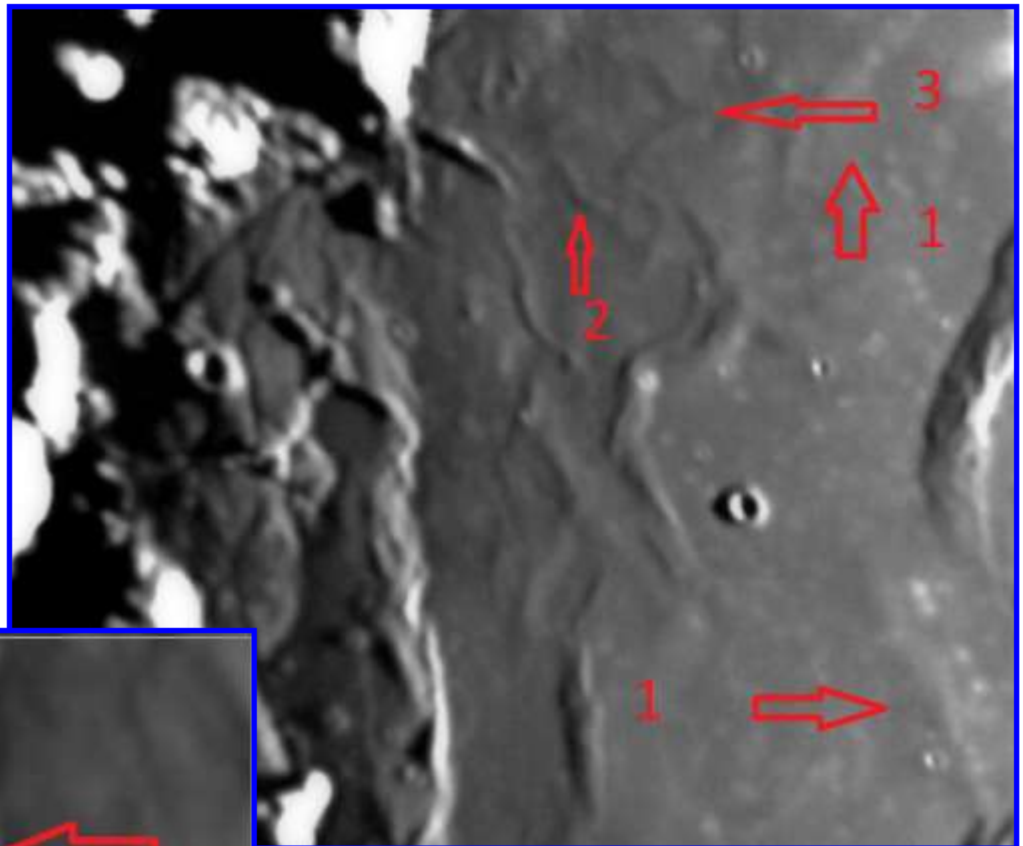


Image 6, Dorsa Aldrovandi*.* *Close-up of image 5. North is down, west is right.*

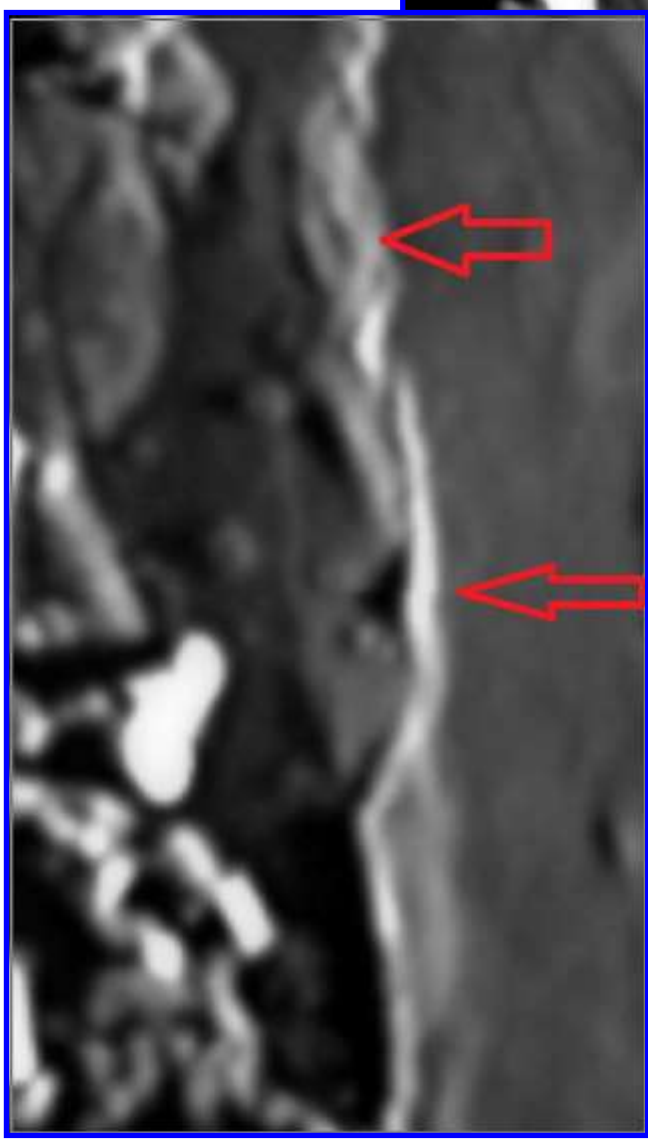


Image 7 Dorsa Aldrovandi*.* *Close-up of image 5. North is down, west is right.*

Lunar Topographic Studies

Detection and Identification of Two Rilles South of Crater Linnè G PART II.

Raffaello Lena and KC Pau

Introduction

This work is a supplement to a report about two elusive rilles that were found by Pau in the north-western corner of Mare Serenitatis and previously published by the authors in [1-2]. Lena temporarily named the rilles as R1 and R2 respectively in the first report [1-2]. Recently more data of these rilles are collected and new tools ACT Layers from LROC QuickMap have been employed to identify if the rilles are real. The results agree with our previous work. For future convenient correspondences about these rilles with other observers, Pau now re-names, also if unofficially, the rilles as Rima Kan 1 and Rima Kan 2 in honor of his wife, who always fully supports his lunar observation.

Rimae Kan is hidden solitarily in the north-western corner of Mare Serenitatis and is not very far away to the east of Montes Caucasus. All around Rima Kan are many mare ridges (Fig 1). It is not easy to detect these rilles under normal lighting condition, only when it is close to the terminator. Steady seeing seems to be an important factor.

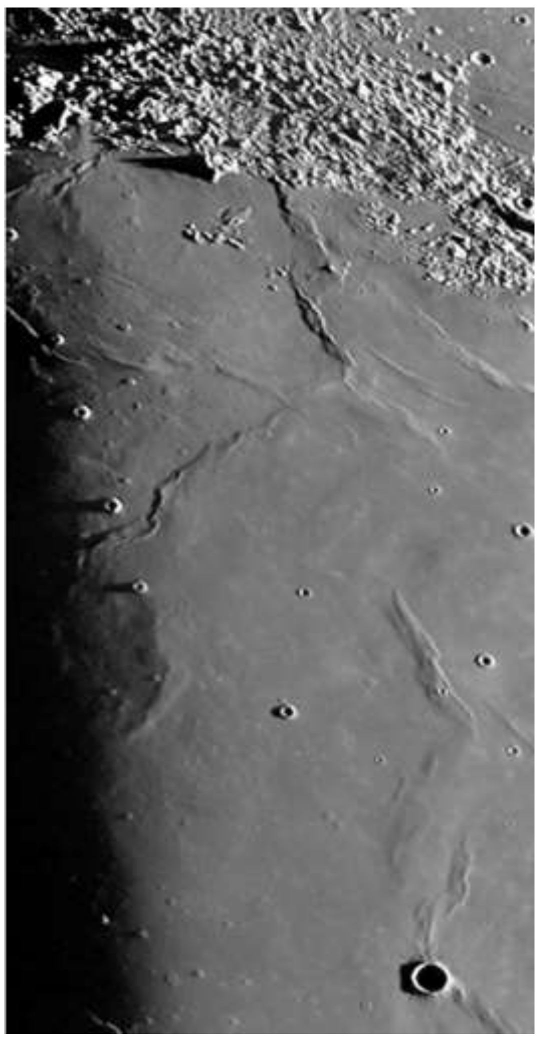


Figure 1: *Image taken on May 21, 2018 at 11:49 UT with 250mm f/6 Newtonian reflector at prime focus with QHYCCD290M camera.*

Detection and Identification of Two Rilles South of Linné G Part II
R. Lena and KC Pau

From photos taken near the morning terminator, it is found that the western part of Rima Kan 2 seems to end at a piece of highland or probably a cliff which casts a prominent shadow under morning sunlight. The cliff has a long narrow mare ridge linked to its south. But the rille seems to extend westwards after crossing over the raised soil. The extension is only barely shown on the photo (Fig. 2).

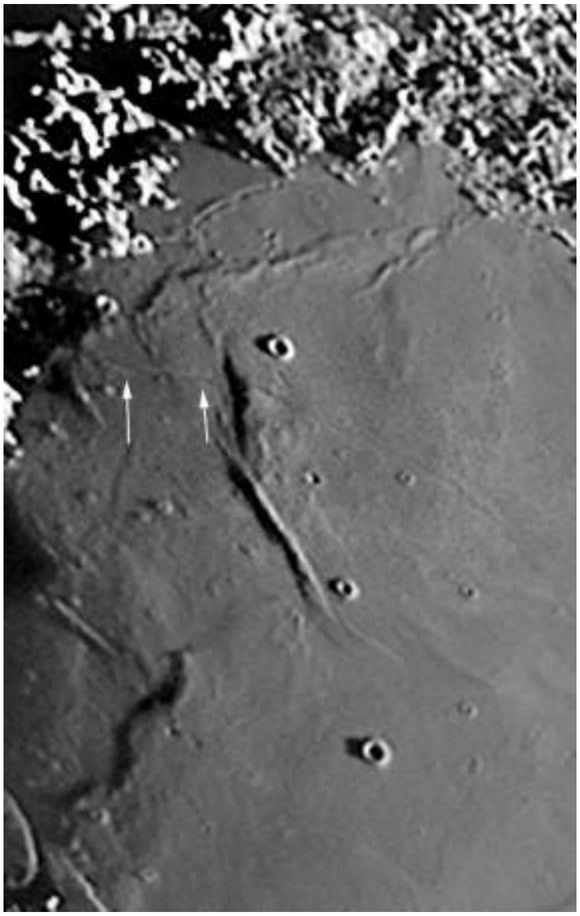


***Figure 2**: Image taken on April 29, 2020 at 11:27 UT with 250mm f/6 Newtonian reflector at prime focus with QHYCCD290M camera.*

Rendered Image using ACT react quick map based on the shaded relief

ACT react quick map (://quickmap.lroc.asu.edu) was used to generate synthetic view of selected parts of the LOLA DEM, using the "shaded relief" parameter for several lighting with specific simulation based on date and time in UT. The rendered images display the lunar features under different solar illumination angles when a date/time in UT is selected (Fig. 3).

The image of Figure 3 shows unequivocally two identified rilles, which appear to be two lunar graben.

Detection and Identification of Two Rilles South of Linné G Part II

R. Lena and KC Pau

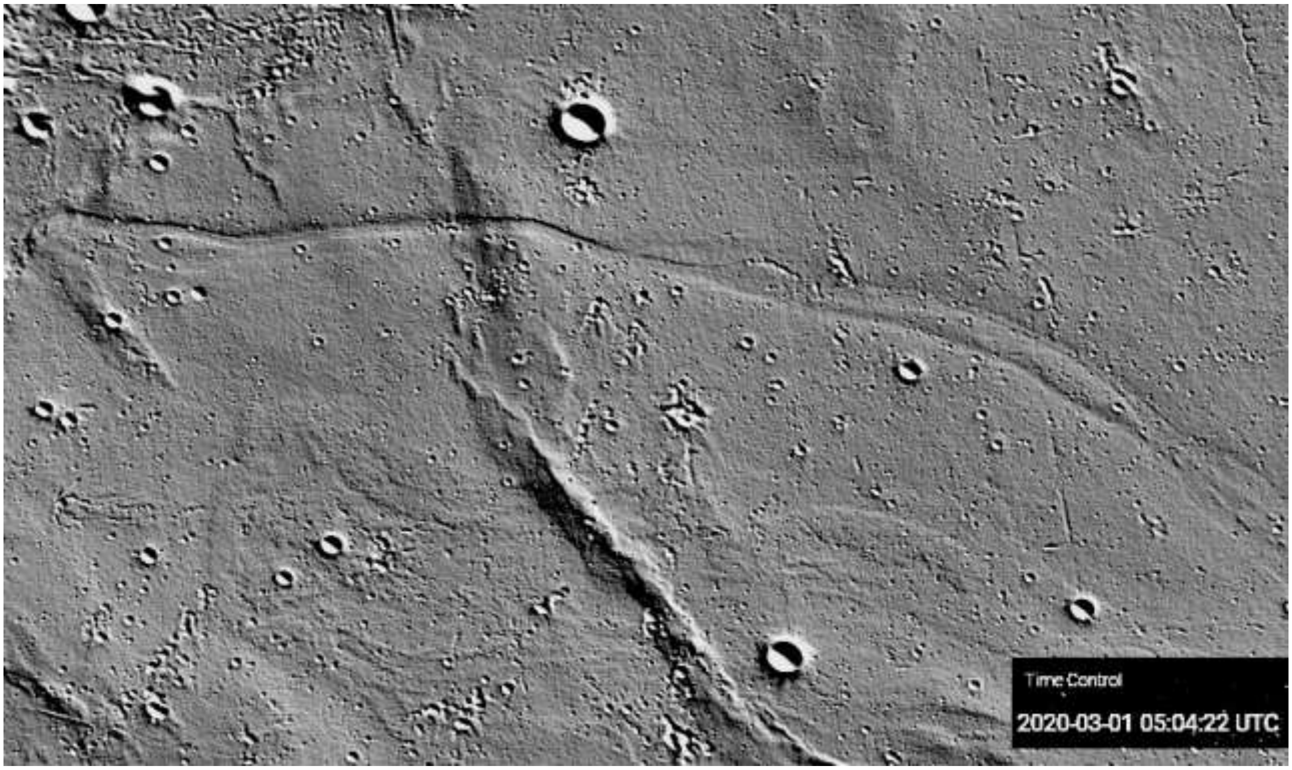


***Figure 3**: specific simulation based on ACT react quick map shaded relief. The rendered image displays the appearance of two rilles as seen for March, 1, 2020 at 05:04 UT. The resulting rendered image was enhanced in contrast and a high pass filter was applied.*

Using the ACT-REACT tool, and LOLA DEM, it is possible determine distances, profiles and depths of several lunar features. At the northern branch, the rille Kan 2 (R2) south of Linnè G is only about 22 m deep, while the southern branch is about 17 m deep (Fig. 4). The average width of the least-disturbed linear sections amounts to ~1,600 m. The rille Kan 1 (R1) is 50 km long while the rille Kan 2 (R2) is about 110 km long.

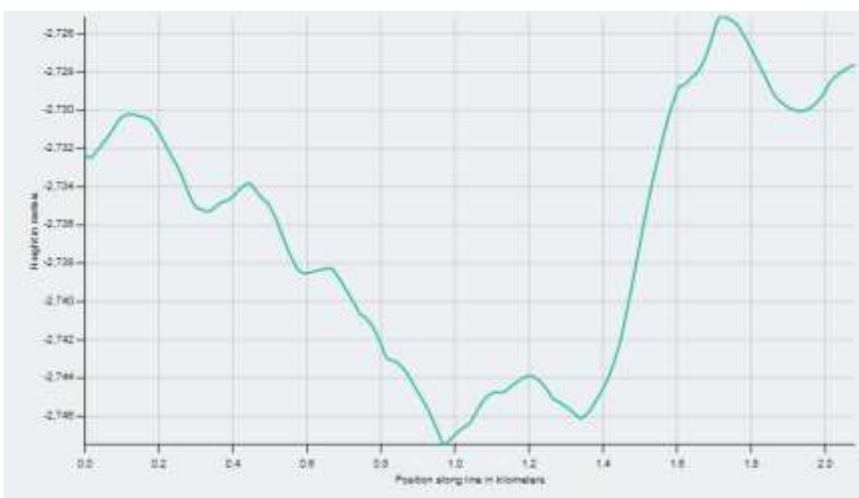


***Figure 4:** Cross-sectional profile of the rille Kan 2 (R2), derived with the ACT-REACT Quick Map.*

Figure 5 displays the region under analysis using the digital elevation model.

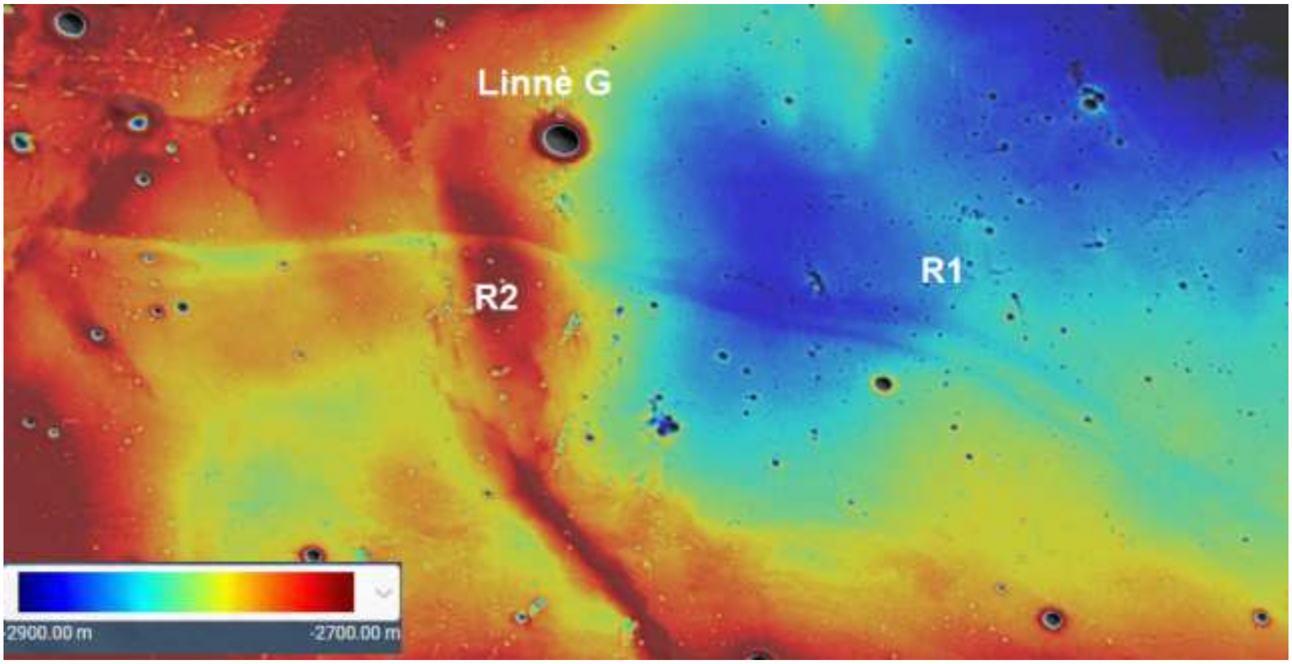


Figure 5: *Digital elevation model of the examined region.*

Note that the rille Kan 2 cuts an elevated soil as also detectable in Fig. 3. This relationship suggests that the rille is younger than the ridge.

Discussion and geologic context

Lunar rilles can have different origin. A graben form by the dropping downward of a linear block between two parallel faults. On the other hand, sinuous rilles are volcanic lava tubes and channels. Linear and concentric rilles are tectonic cracks generally associated with stresses related to impact basins. Linear rilles are also interpreted as depressions formed over rising of magma, called dikes. The dikes rise through regions where a horizontal stress is extensional, making it easier for the dike to push aside the surrounding rocks. The *Sirsalis* rille, a linear rille, is one of the longest lunar graben, about 380 km long, for which is identified an origin due to rising magma by a dike [3].

Tectonic origin: for many linear rilles on the Moon, their locations relative to impact basins and their orientation geometries strongly suggest that they are graben produced by large-scale tectonic stresses [4]. Filling of the circular impact basins, such as Imbrium, Serenitatis and Crisium, by mare basalts caused central loading of the lithosphere, flexure, and the formation of circumferential graben at locations around the basins; the radial distance of graben formation is a function of the load magnitude and the elastic lithosphere thickness. Thus, this mechanism could be the origin of two concentric rilles under investigation.

Intrusion of dikes: the presence of volcanic features associated with various lunar linear rilles is evidence that at least some linear rilles are graben whose formation is related to the shallow intrusion of dikes [3].

Mare volcanic eruptions are fed from source regions at the base of the crust or deeper in the lunar mantle. According to Wilson and Head [3], some dikes intruded into the lower crust while others penetrated to the surface, being the sources for extensive outpourings of lava. Thus, the surface manifestation of dike emplacement in the crust is depending on the depth below the surface to which the dike penetrates. Wilson and Head state that if a dike does not propagate near the surface but stalls at greater depth, the strain will be insufficient to cause any dislocation near the surface. If a dike propagates at intermediate depths the strain will cause extensional deformation, eventually leading to graben formation.

On the contrary, if a dike propagates at shallow depth and gains surface access at some points, a subsequent lava effusion will occur and the surface manifestation of the dike will be a fracture. Depending on the magma density relative to the density of the crust and the mantle, and also on the stress state of the lithosphere, some dikes erupt at the surface while others penetrate to depths shallow enough to produce linear graben.

Bouguer gravity anomalies and crustal thickness: the analysis of gravity data is a useful approach for characterizing the subsurface crustal and interior structure of a planetary body. Grail dataset obtained by the ACT Quick Map *LRO* (http://target.lroc.asu.edu/da/qmap.html) has been used for Bouguer gravity mass anomaly [5] and for crustal thickness [6]. Figure 6 displays the gravity anomaly of the examined region. Gravity anomaly mass concentrations are concentrated in the examined region including Linnè G and the two rilles. The gravity anomaly is shown in red color (Fig. 6) and is obtained from the GRAIL GRGM900C gravity model after subtracting the gravity resulting from topography assuming a density of 2,550 kg m^{-3}. Consequently, these data also indicate variations in thickness of the crust. If the density of the crust is assumed to be uniform, then the gravity anomalies visible in the Bouguer gravity map can be explained by variations in the thickness of the crust. Highs in gravity indicate places where the mantle is closer to the surface, and hence where the crust is thinner. The gravity anomaly indicates the presence of magma chamber at low depth.

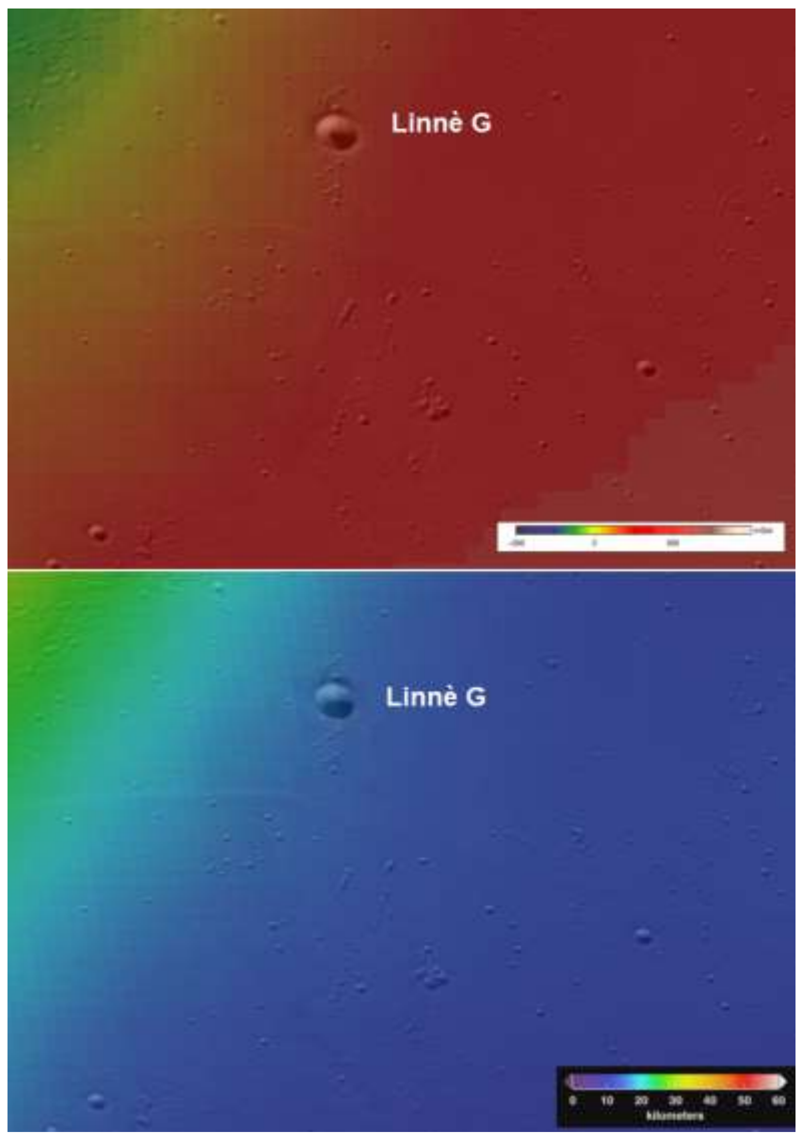


Figure 6: *(Top) Bouguer gravity gradients of the examined region. (Bottom) GRAIL crustal thickness map at 16pixels/degree. It includes shaded relief of surface features.*

Wilson and Head propose that lunar linear rilles like Rima Sirsalis and Rima Parry V are the surface manifestations of dikes which have not reached the surface but propagated to shallow depths of 1–2 km, showing that these dikes were capable of producing surface stress fields leading to the development of graben with widths of 1–3 km [3]. Note that the average width of the least-disturbed linear sections of the examined rilles discovered by Pau amounts to ~1,600, thus in accord with the derived values for Rima Sirsalis.

Conclusion

Our new data show very clearly there are two long and elusive rilles, oriented roughly radially with respect to Mare Imbrium. In order for igneous dikes to form, the lunar lithosphere would also have to be under extension, and thus this tectonic regime is conducive to both dike and graben formation. Based on the methodology used here, we cannot distinguish between graben formation with or without dike intrusion, as both processes have the potential to produce all of the geomorphologic characteristics of normal faults described in this study. Likely both mechanisms can have occurred, including dike propagation in the subsurface.

It once again shows that with today imaging technology, there is still a chance for amateurs to study elusive features on the moon. In combination with high-resolution images, such investigations might greatly extend our present knowledge of the processes occurred on the Moon.

References

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[3] Head, J.W., Wilson, L. Lunar graben formation due to near-surface deformation accompanying dike emplacement, Planetary and Space Science, Volume 41, Issue 10, 1993, Pages 719-727, ISSN 0032-0633, https://doi.org/10.1016/0032-0633(93)90114-H.

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Use of the Principal Component Transformation to Process Six Bands of Imagery

Darryl Wilson

This ninth article in the multiband image processing series shows the power behind the principal component transformation (PCT) as we simultaneously process six images of the moon, each taken through a different color filter, to reveal previously invisible wavelength dependent (spectral) information.

Figure	Band	UT	Filter	Exp.	Gain (dB)
3	UV	0058	UV+IR_BLK	1/15	25.13
4	Violet	0107	#47+IR_BLK	1/177	9.98
5	Blue	0154	IR_BLK	1/6061	9.98
6	Green	0154	IR_BLK	1/6061	9.98
7	Red	0154	IR_BLK	1/6061	9.98
8	NIR	0141	NIR807+POL	1/1000	9.98

Figure 1. *Image Specific Acquisition Details*

The six input bands include the five that were used in last month's TLO article and a near infrared (NIR) band that was captured during the same session. All images were acquired on April 16, 2022 UT. Image specific acquisition details are presented in figure 1. Optics and filter details are presented in Figure 2. Because a clear glass blank was not available, a polarizing filter was inserted into the light path in an effort to equalize focal plane distance with the UV and Violet filter configurations. Lack of its use in the red, green, and blue bands, with consequent changes in focal length, may have been responsible for some of the artifacts visible in the last PC band. Some additional details were presented in the July 2022 TLO article "The Principal Component Transformation Extracts Hidden Information from Multiband Imagery" (p. 12).

Optics/Electronics:
3" Refractor, 400 mm FL, 2.25 arc seconds / pixel, Celestron 274C CCD

Filters:

UV	– Astrodon UVenus UV Filter
#47	– Orion #47 Violet (Made in Japan ~1995)
IR_BLK	– Astronomik NIR Block filter
NIR807	– Astronomik ProPlanet 807 IR
POL	– Lumicon LF1110 polarizing filter

Figure 2. *Optics and filter Details*

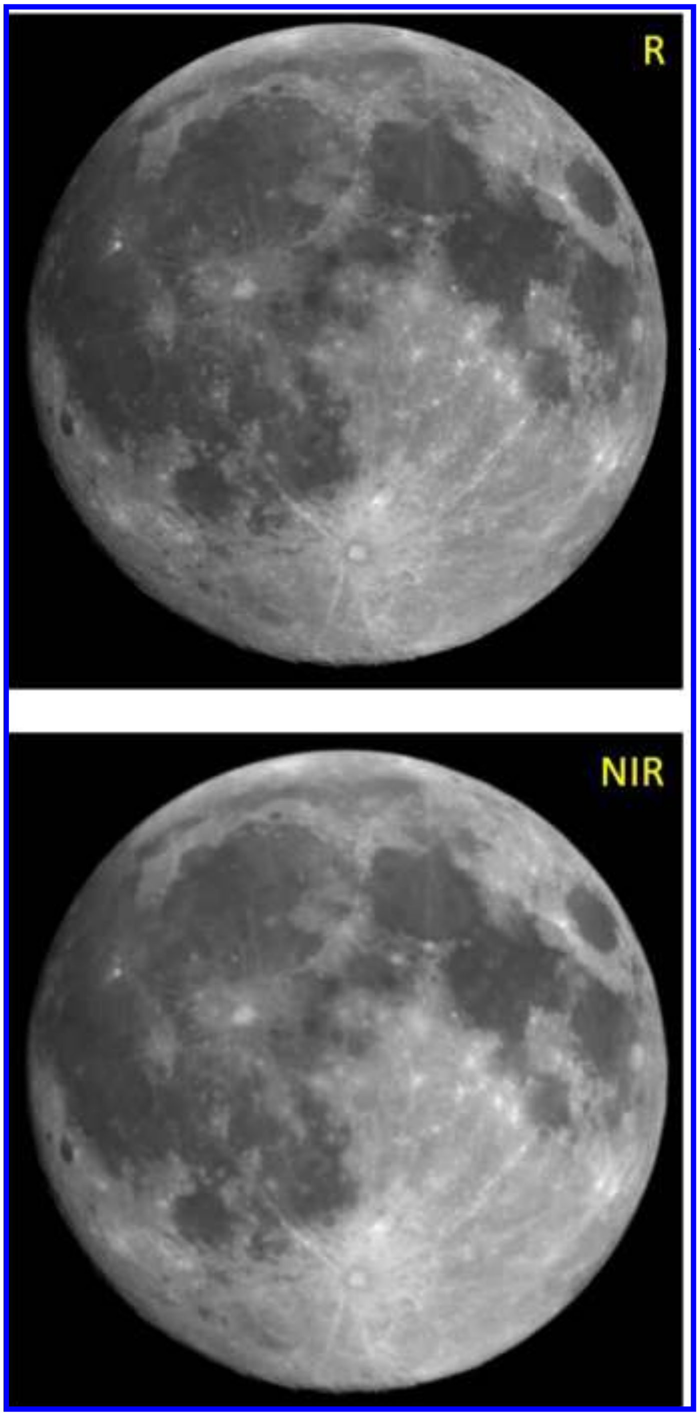
Figure 3 is an ultraviolet (UV) image of the moon. Figure 4 is a violet (V) image. Figures 5, 6, and 7 are blue (B), green (G), and red (R) images respectively. Figure 8 is a NIR image that has been added since last month's article. All images are labeled in the upper right corner.

ON THE RIGHT
Figure 3 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 00:58 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, UV band, exposure 1/15 second, gain 25.13 dB. 2.25 arc seconds/pixel.*

Figure 4 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:07 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, Violet band, exposure 1/177 second, gain 9.98 dB. 2.25 arc seconds/pixel.*

ON THE LEFT
Figure 5 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, Blue band, exposure 1/6061 second, gain 9.98 dB. 2.25 arc seconds/pixel.*

Figure 6 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, Green band, exposure 1/6061 second, gain 9.98 dB. 2.25 arc seconds/pixel.*



ON THE LEFT

Figure 7 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, Red band, exposure 1/6061 second, gain 9.98 dB. 2.25 arc seconds/pixel.*

Figure 8 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 01:54 UT. 3 inch refractor telescope, Celestron SKYRIS 274C camera, Near Infrared band, exposure 1/1000 second, gain 9.98 dB. 2.25 arc seconds/pixel.*

If you have never seen UV, visible light, and NIR images presented side-by-side, it may be interesting to spend some time closely examining them for minor albedo differences in various places. Although they all appear the same at first, careful examination reveals differences. There is a progressive increase in contrast in the inner areas of mare Imbrium as longer wavelengths are examined. Western Oceanus Procellarum, near the limb, has a reflectance minimum in the UV with progressive brightening to the NIR, with one exception - a reflectance peak in the violet band. Bright craters seem to brighten further in the UV, but rays seem relatively brighter at longer wavelengths. These slight variations, and others, are the signal that we are trying to amplify through colorspace transformations so that we can see spectral details.

In the July 2022 issue of TLO, we listed nine properties of the PCT. Another way to characterize it is by listing its functions that can be useful to amateur astronomers. They include the following:

1) Anomalous feature detection

2) Sub-visual feature contrast enhancement

3) Sensor noise characterization

4) Sensor noise reduction

5) Color enhancement

This article will illustrate functions 1 and 2.

Principal component (PC) output bands are presented in Figures 9 through 14. A comparison with the five PC bands presented last month shows that none of the new PC bands exactly match any of the previous five. This is because the new NIR input band changed the overall statistics of the group. Since the PCT is based on scene statistics, output results depend on the unpredictable collection of pixel values that are input to the algorithm. This algorithm's output results only indirectly depend on the surface material composition of areas within the input scene. As stated in PCT properties 3 and 4 last month, the PCT cannot be used to identify minerals on the lunar surface, but it is exceptionally good at discriminating between one and another based on wavelength dependent (i.e., spectral) differences. So, it can't tell us that ilmenite is present at position A, and pyroxene is present at position B, but it will show us the something is different between positions A and B if that information exists within the data.

ON THE RIGHT
Figure 9 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 1, UV, V, B, G, R, NIR..*

Figure 10 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 2, UV, V, B, G, R, NIR..*

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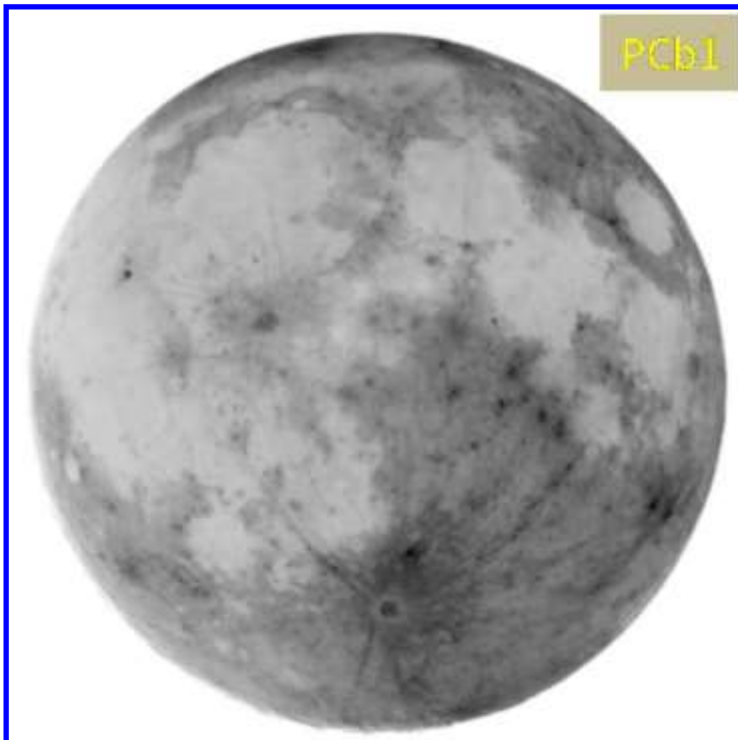
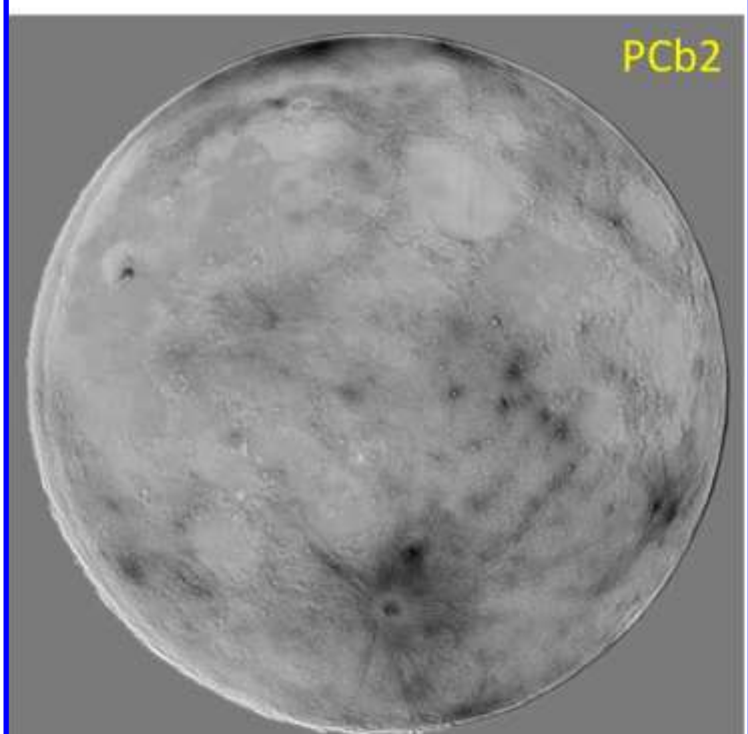
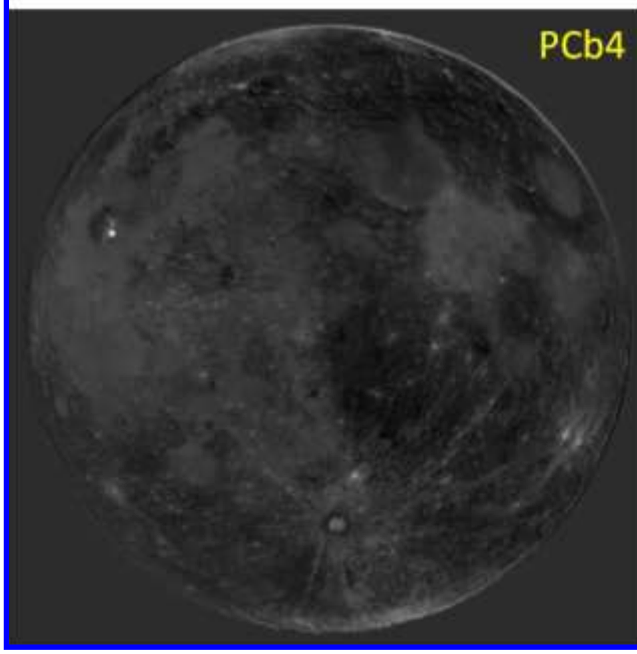


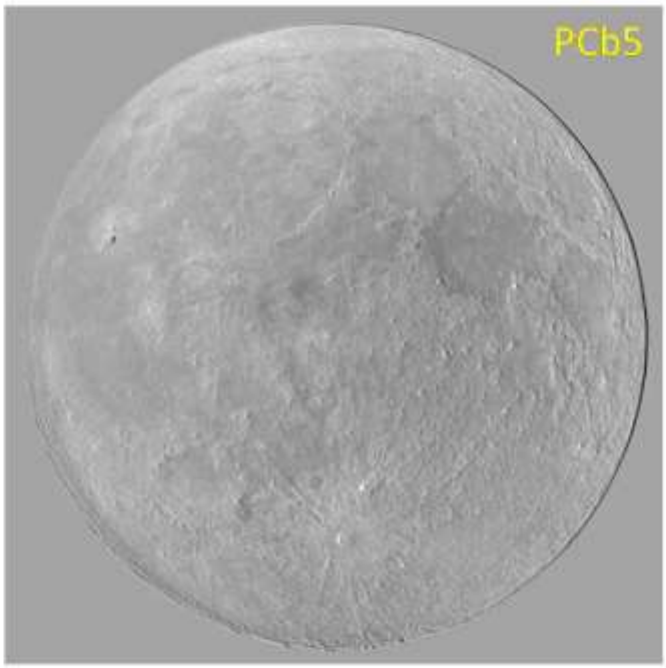


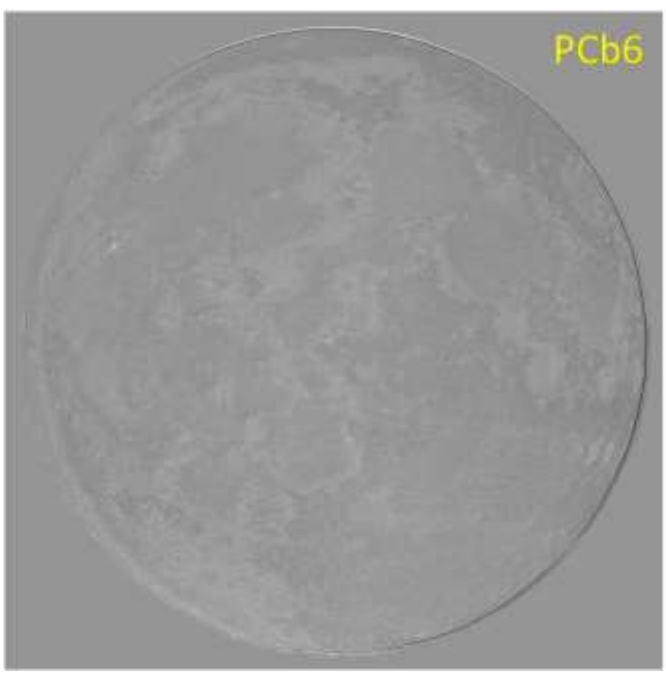
ON THE RIGHT

Figure 11 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 3, UV, V, B, G, R, NIR..*

Figure 12 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 4, UV, V, B, G, R, NIR..*







ON THE LEFT

Figure 13 (top), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 5, UV, V, B, G, R, NIR..*

Figure 14 (bottom), Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 5, UV, V, B, G, R, NIR..*

Figure 15, PC band 3, shows many of the contrast patterns in the maria that we have previously seen in color enhanced imagery. Close inspection of Sinus Iridum shows numerous subtle brightness patterns that are not normally captured using a 3" refractor. Likewise, the area of northwest Mare Imbrium just south of Plato presents detailed patterns of shading variations that were not visible in the HSV based color enhanced images taken through an 18" scope (DEC 2021 TLO). The addition of spectral information outside the visible range of the spectrum, mathematically combined with the visible R, G, and B bands has made this possible.

Figure 16, PC band 4, presents a strikingly different picture. At first glance, it almost seems to be a different celestial body. Mare Tranquillitatis is eye-catchingly bright. Moving westward past the Caucasus Mountains, Aristillus stands out from its surroundings due to its spectrally distinct composition. Note the exceptionally rich patterns of brightness variations in western Oceanus Procellarum, as well as the northern brightening in Mare Fecunditatis. This is a good example of the results that might be expected when six different spectral bands that cover more than an octave of spectral range are input to the PCT.

Figure 15, Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 3, Gaussian stretch.*

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Figure 16, Moon, *Darryl Wilson, Marshall, Virginia, USA. 2022 April 16 Principal Component Band 4, Gaussian stretch.*

Last month, we avoided discussion of the mathematics of the PCT. This month, we take a peek at some of the action. Figure 17 is a table of the PCT Eigenvectors that were used to calculate the six PC bands presented here. The rows contain the coefficients that were applied to the input bands to generate each output PC band, but we don't have to track those calculations to gain insight. A simple, qualitative examination of the table can explain some of what we are seeing. The row labeled PC Band 3 has six numbers. Three are positive and three are negative. The positive numbers are in the Blue, Green, and Red columns. This means that the visible bands made the positive contributions to PC band 3. Indeed, PC band 3 appears similar to visible light images of the moon. The row labeled PC band 4 also has six numbers. The numbers in the Violet and the NIR columns are much larger than the numbers in the other four columns. This means that contributions from the violet and the NIR bands dominated the calculations. PC band 4 can be roughly approximated by simply subtracting the NIR band from the violet band. The violet band blocked most light from 450 nm to 730 nm - it passed violet and NIR light. The NIR band only passed wavelengths longer than 807 nm. PC band 4 was mainly generated using input from light outside the visible spectrum. Why does it look so unfamiliar? Because no human eye has ever seen the moon that way before.

Principal Component Transformation Eigenvectors						
	UV Band	Violet Band	Blue Band	Green Band	Red Band	NIR Band
PC Band 1	-0.505706	-0.468540	-0.354731	-0.373623	-0.359877	-0.360268
PC Band 2	-0.839278	0.393310	0.009613	0.207221	0.222698	0.219753
PC Band 3	-0.129395	-0.537846	0.392768	0.512653	0.353187	-0.390074
PC Band 4	0.035043	0.579287	0.099873	0.044344	-0.155106	-0.791959
PC Band 5	0.121534	0.030064	-0.637600	-0.102292	0.725915	-0.200938
PC Band 6	-0.084451	0.004676	0.550726	-0.736358	0.380976	-0.046710

Figure 17. *Principal Component Transform Eigenvectors.*

The PCT allows amateur astronomer to combine information from any number of input images into output bands that each contain weighted information from the entire input data set. It is in this sense that each output band contains a mathematically optimal amount of information from the entire set of input bands. Easy to use since there are no input parameters to adjust, the PCT often reveals hidden, invisible information from the input imagery.

In this article, we presented six bands of color imagery that spanned the UV to the NIR regions of the spectrum. Five functions of the PCT were listed, of which two were covered herein. We used the PCT to generate six output bands, and focused our attention on the middle two. We noted that these PC bands were not duplicates of any of the five bands presented last month, even though five of the input bands were identical, because a change in the statistics of the input imagery changes the PCT output results. PC band 3 was seen to contain much information present in visible light images of the moon, but with enhanced contrast of sub-visual features. PC band 4 was found to be completely different due to its generation primarily from input bands outside the visible spectrum. We briefly related the eigenvectors of the PCT to the characteristics of PC bands 3 and 4. Finally, we expounded on the virtues of the PCT that can benefit amateur astronomers.

Full Moon, *Jario Chavez, Popayán, Colombia. 2022 July 14 01:09 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

Catena Sylvester, *Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:20 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Waxing Crescent Moon, 21%, *Jario Chavez, Popayán, Colombia. 2022 July 03 23:35 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

Mare Fecunditatis, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:27 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Rosse and Rosse C, *István Zoltán Földvári, Budapest, Hungary. 2022 July 18, 00:46-01:13 UT, colongitude 141.06-141.29 degrees. 127 mm Maksutov-Cassegrain telescope, 1500 mm focal length, 150 x. Seeing 4/10, transparency 6/6.*

Recent Topographic Studies

***Hayn,** Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:21 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

***Walter,** Jario Chavez, Popayán, Colombia. 2022 July 06 23:07 UT. 311 mm reflector telescope, MOTO E5 PLAY camera. North is to the lower right, west is to the upper right.*

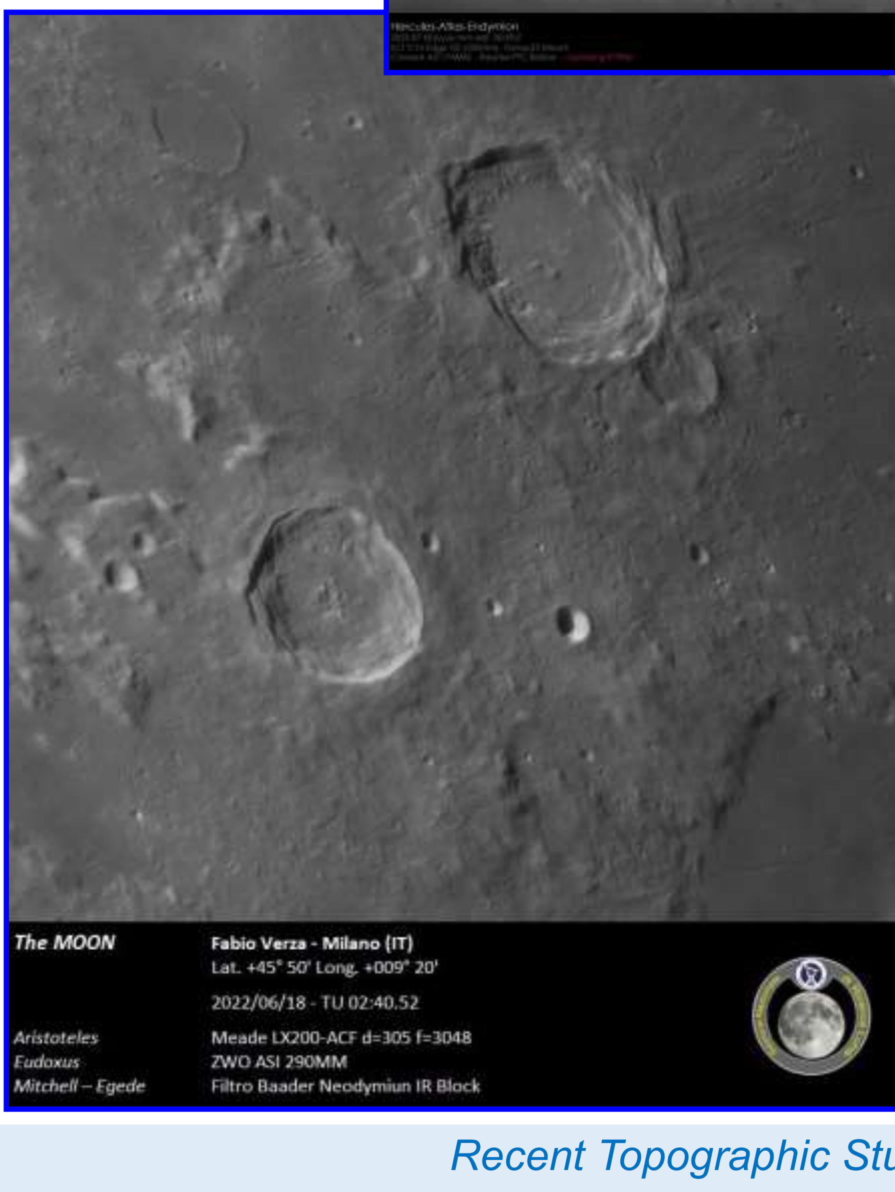
Recent Topographic Studies

Piccolomini, *Luigi Morrone, Agerola, Italy. 2022 July 05 18:55 UT. Celestron 14 Edge HD Schmidt-Cassegrain telescope, Fornax 52 mount, Baader FFC barlow, Optolong R filter, ASI174mm camera.*

Copernicus, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 19:44 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

Recent Topographic Studies

Hercules, *Luigi Morrone, Agerola, Italy. 2022 July 05 18:32 UT. Celestron 14 Edge HD Schmidt-Cassegrain telescope, Fornax 52 mount, Baader FFC barlow, Optolong R filter, ASI174mm camera.*

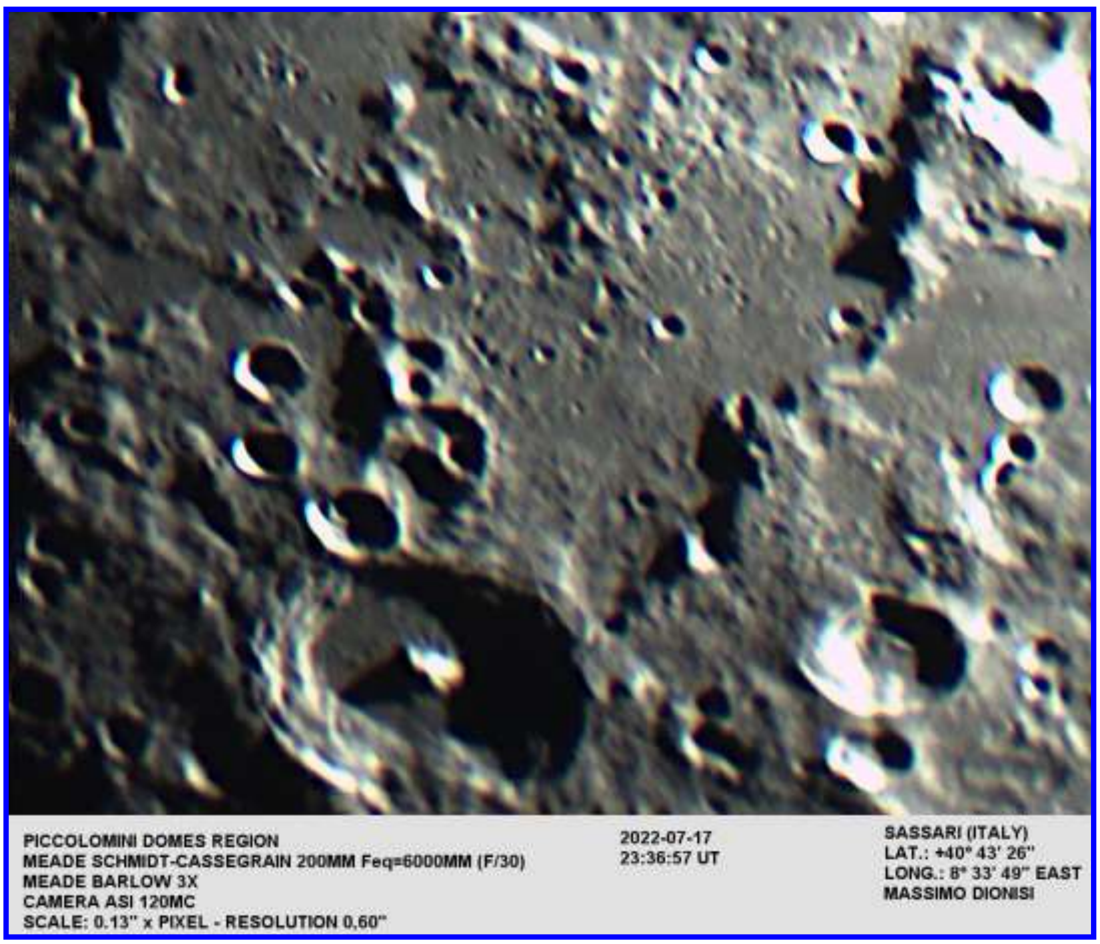


Aristoteles, *Fabio Verza, SNdR, Milan, Italy. 2022 June 18 02:40 UT. Meade LX200 12 inch Schmidt-Cassegrain telescope, Baader Neodymium IR block filter, ZWO ASI290MM camera.*

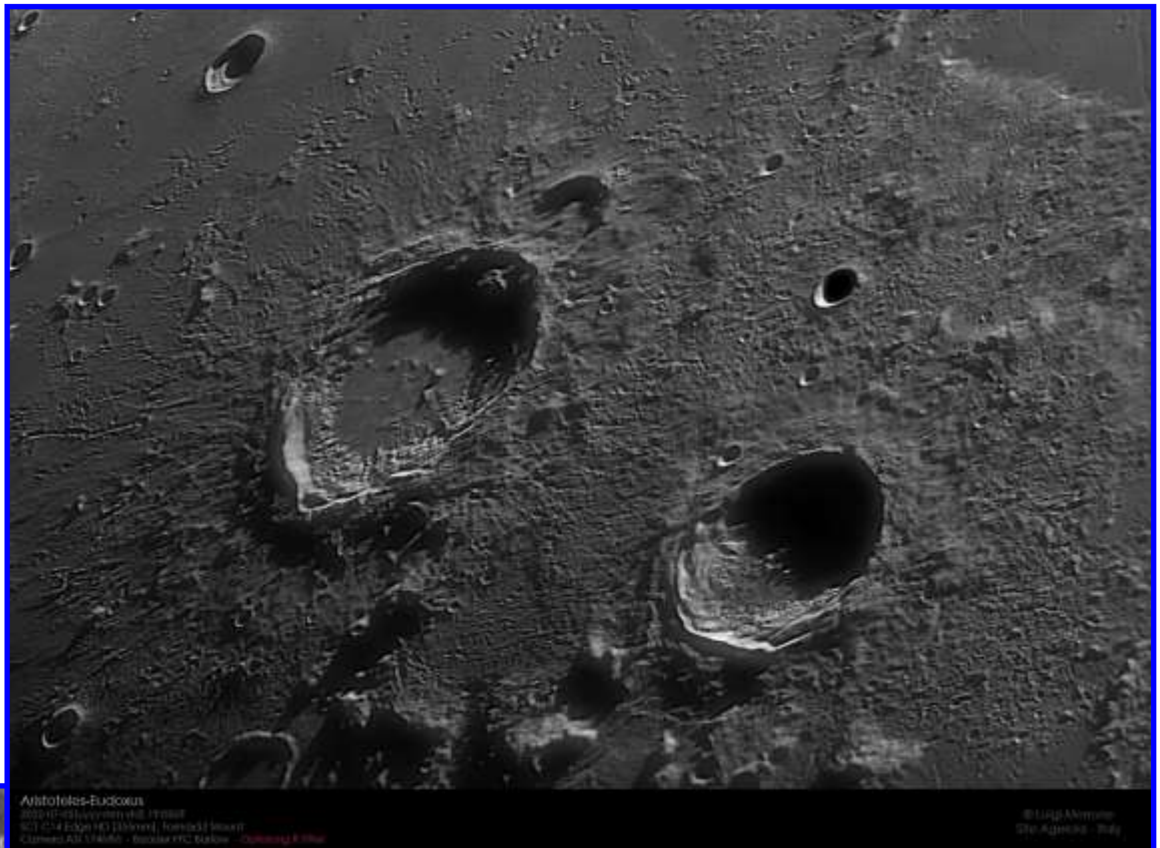
Recent Topographic Studies

Hayn, *Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:16 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Piccolomini, *Massimo Dionisi, Sarrari, Italy. 2022 July 17 23:36 UT. 8 inch Meade Schmidt-Cassegrain telescope, 3x barlow, ASI 120MC camera. North is to the upper left, west is to the upper right.*



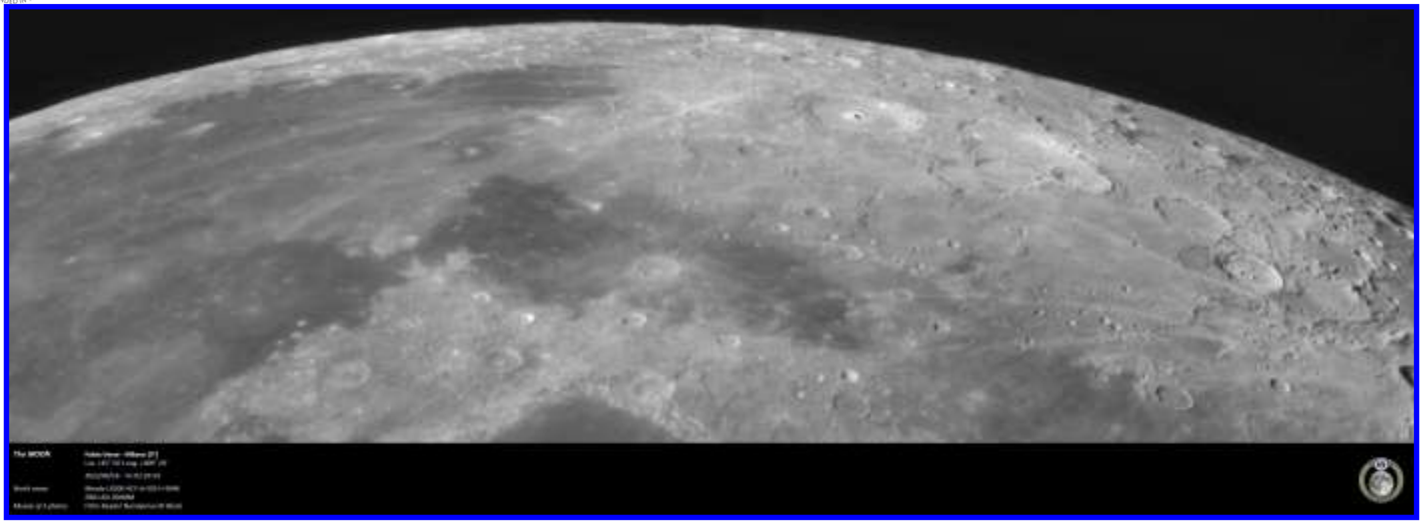
Recent Topographic Studies



Aristoteles and Eudoxus, *Luigi Morrone, Agerola, Italy. 2022 July 05 19:05 UT. Celestron 14 Edge HD Schmidt-Cassegrain telescope, Fornax 52 mount, Baader FFC barlow, Optolong R filter, ASI174mm camera. North is left, west is down.*

Mare Humorum, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:18 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Recent Topographic Studies



Northern Moon, *Fabio Verza, SNdR, Milan, Italy. 2022 June 18 02:29 UT. Meade LX200 12 inch Schmidt-Cassegrain telescope, Baader Neodymium IR block filter, ZWO ASI290MM camera.*

Waxing Crescent Moon, 14%, *Jario Chavez, Popayán, Colombia. 2022 July 03 00:56 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

Lacus Mortis, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:31 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Copernicus, *Maurice Collins, Palmerston North, New Zealand, 2022 July 08 05:35 UT. Meade ETX-90 Maksutov-Cassegrain telescope, IR850 filter, QHY5III462C camera.*

Recent Topographic Studies

Wallace, *KC Pau, Hong Kong, China, 2019 February 13 11:14 UT. 10 inch f/6 Newtonian reflector telescope, 2.5 x barlow, QHY-CCD290m camera.*

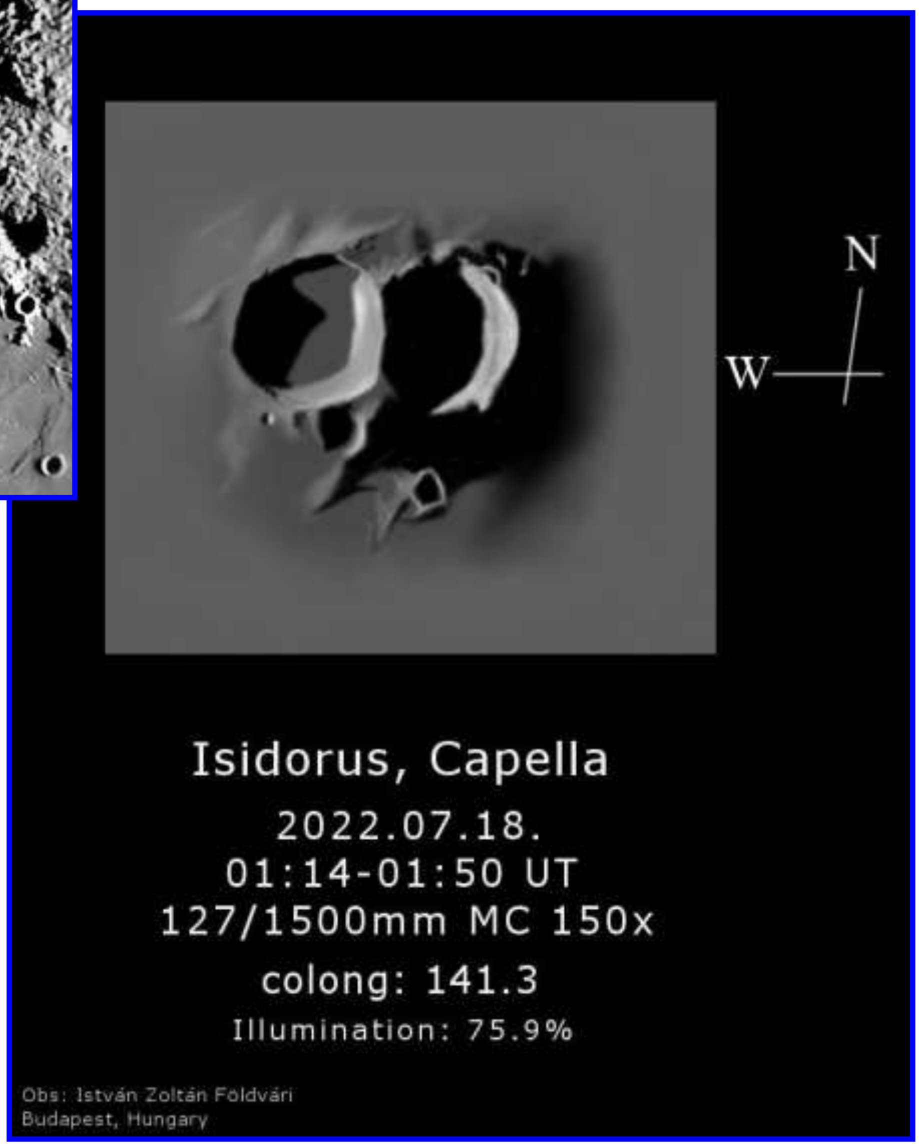
KC adds: Enclosed is a photo of hillocks west of Wallace under early morning sunlight taken with 10" f/6 Newtonian reflector + 2.5X barlow + QHYCCD290M camera on 13Feb2019 at 11h14m UT. The members of hillock group cast wonderful needle-shaped shadows. What caught my attention is a delicate rille (indicated with arrows) that runs between Eratosthenes D and E, which is a closed pair of twin craters with diameter of 3.8 km. With reference to QuickMap, the rille emerges from a small crater just north of Eratosthenes D. It then runs northwards and passes the western side of Eratosthenes E. It terminate its northward journey at a small crater. The total length of the rille is about 46 km and its width is about 1 km.

Meton, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:59 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter,*

Recent Topographic Studies

Wallace, *KC Pau, Hong Kong, China, 2017 May 04 12:27 UT. 10 inch f/6 Newtonian reflector telescope, 2.5 x barlow, QHYCCD290m camera.*

KC adds: Another photo showing the illuminated ring effect of Wallace under morning sunlight. The photos is also taken with 10" f/6 Newtonian reflector + 2.5X barlow + QHYCCD290M camera on 4May2017 at 12h27m UT. Wrinkle ridges north of Wallace stands out brilliantly under oblique morning sunlight, as well as the magnificent shadows from Mt. Apenninus.



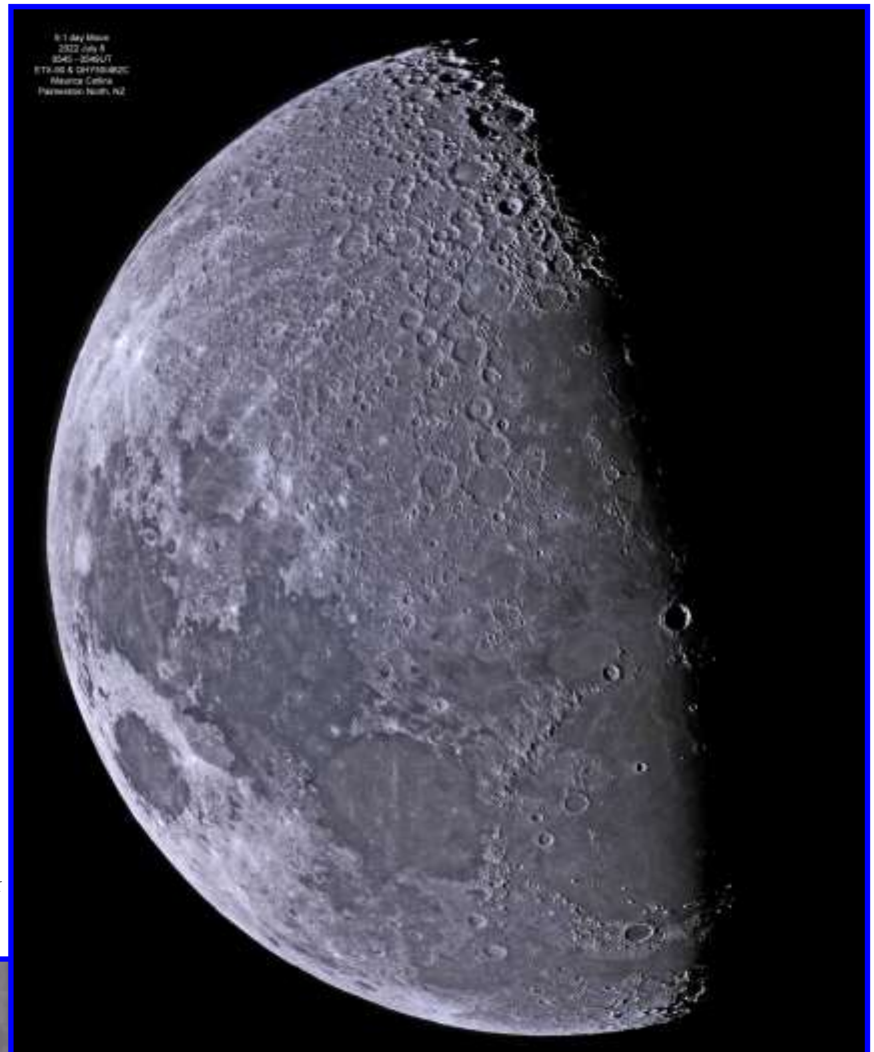
Isidorus and Capella, *István Zoltán Földvári, Budapest, Hungary. 2022 July 18, 01:14-01:50 UT, colongitude 141.3 degrees. 127 mm Maksutov-Cassegrain telescope, 1500 mm focal length, 150 x. Seeing 3-4-5/10, transparency 6/6.*

Recent Topographic Studies

Plato, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:54 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Waxing Gibbous Moon, *Leonardo Alberto Colombo, Córdoba, Argentina. 2022 July 08 01:49 UT. 200 mm objective, Baader 685 nm filter, QHY5-IIM camera.*

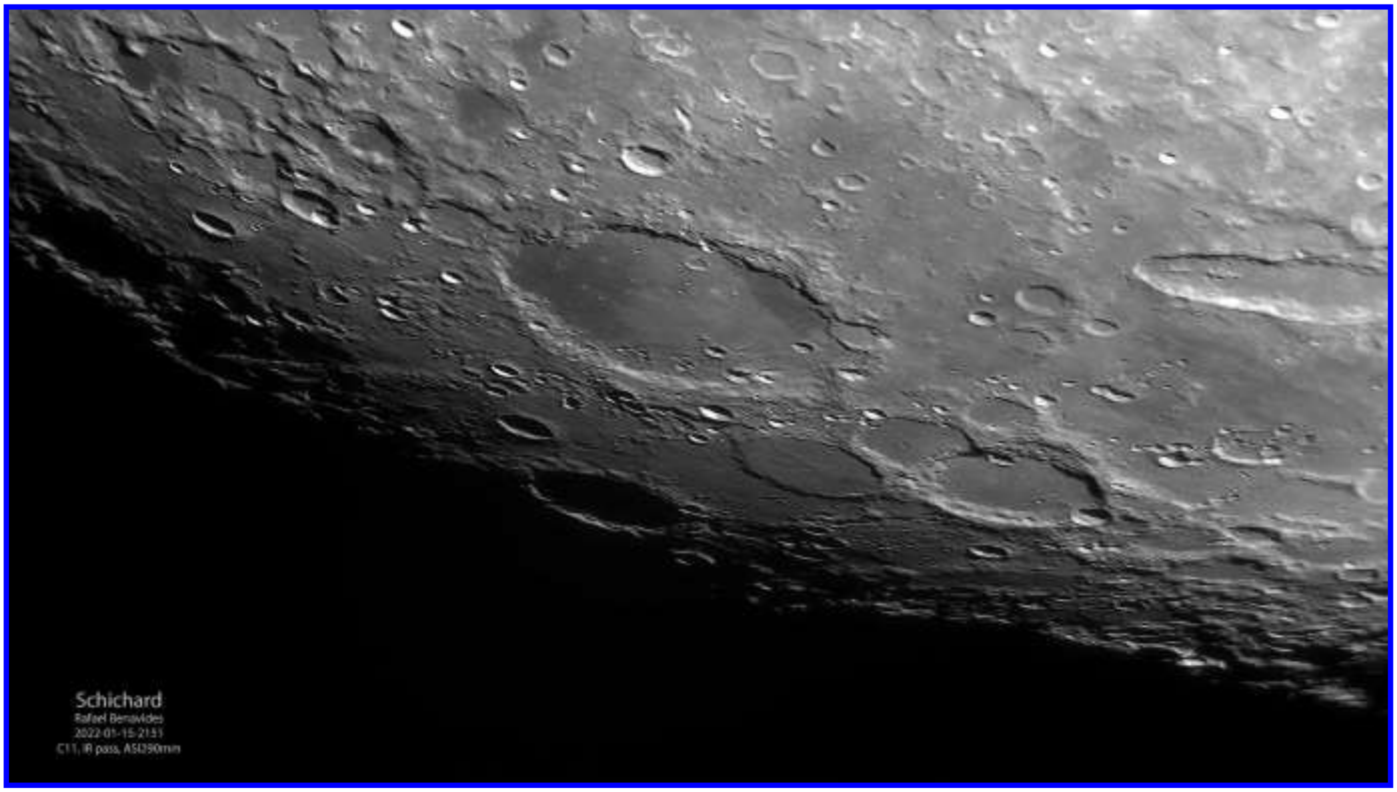
Recent Topographic Studies



9.1 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 July 08 05:45 -05:49 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

Mare Vaporum, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:08 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

Recent Topographic Studies



Schickard, *Rafael Benavides, Posadas Observatory MPC J53, Córdoba, Spain. 2022 January 15 21:51 UT. Celestron 11 inch Schmidt-Cassegrain telescope, IR Pass Baader Planetarium filter, ZWO ASI290 mm camera. Seeing 7/10, transparency 5/6.*

Montes Caucasus, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:55 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

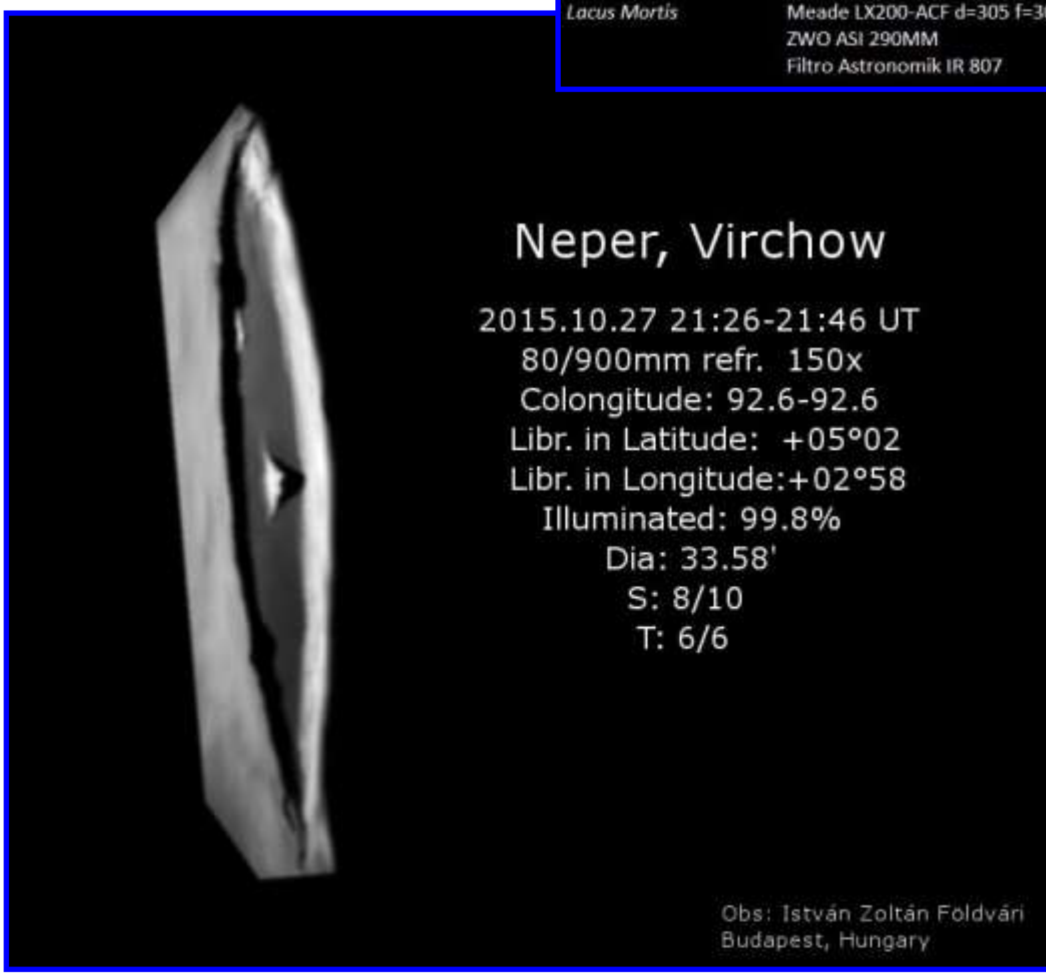
Recent Topographic Studies

Janssen, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:06 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

Rupes Recta, *Massimo Dionisi, Sarrari, Italy. 2022 July 07 21:35 UT. 8 inch Meade Schmidt-Cassegrain telescope, ASI 120MC camera. North is to the upper left, west is to the upper right.*

Recent Topographic Studies

Lacus Mortis, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:00 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*



Neper and Virchow, *István Zoltán Földvári, Budapest, Hungary. 2015 October 27, 21:46-21:46 UT, colongitude 92.6 degrees. 80 mm refractor telescope, 900 mm focal length, 150 x. Seeing 8/10, transparency 6/6.*

Recent Topographic Studies

Endymion, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 02:23 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

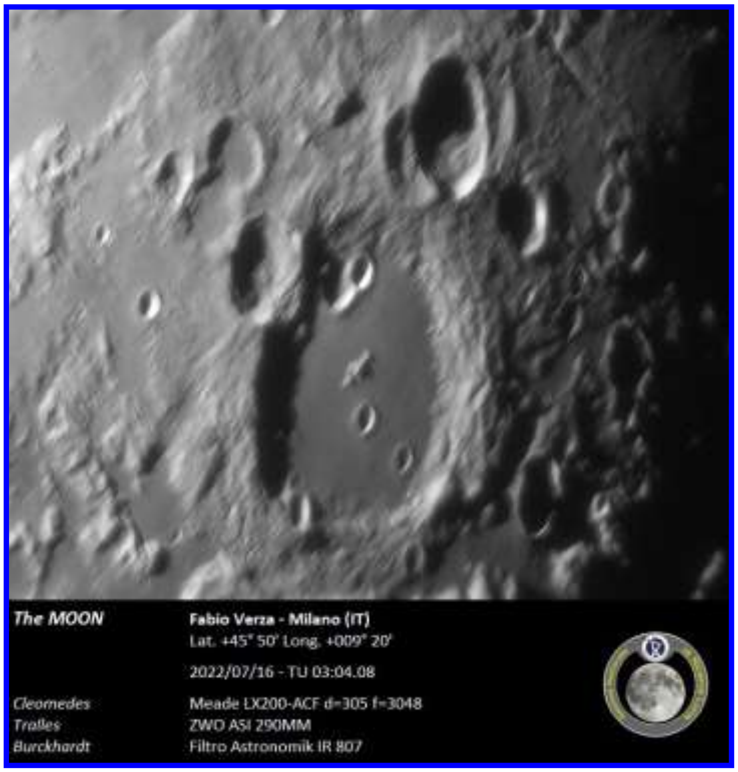
Waxing Crescent Moon, 40%, *Jario Chavez, Popayán, Colombia. 2022 July 06 01:37 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

Atlas, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:02 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

Clavius and Moretus, *Rafael Benavides, Posadas Observatory MPC J53, Córdoba, Spain. 2022 January 11 20:59 UT. Celestron 11 inch Schmidt-Cassegrain telescope, IR Pass Baader Planetarium filter, ZWO ASI290 mm camera. Seeing 7/10, transparency 5/6.*

Recent Topographic Studies



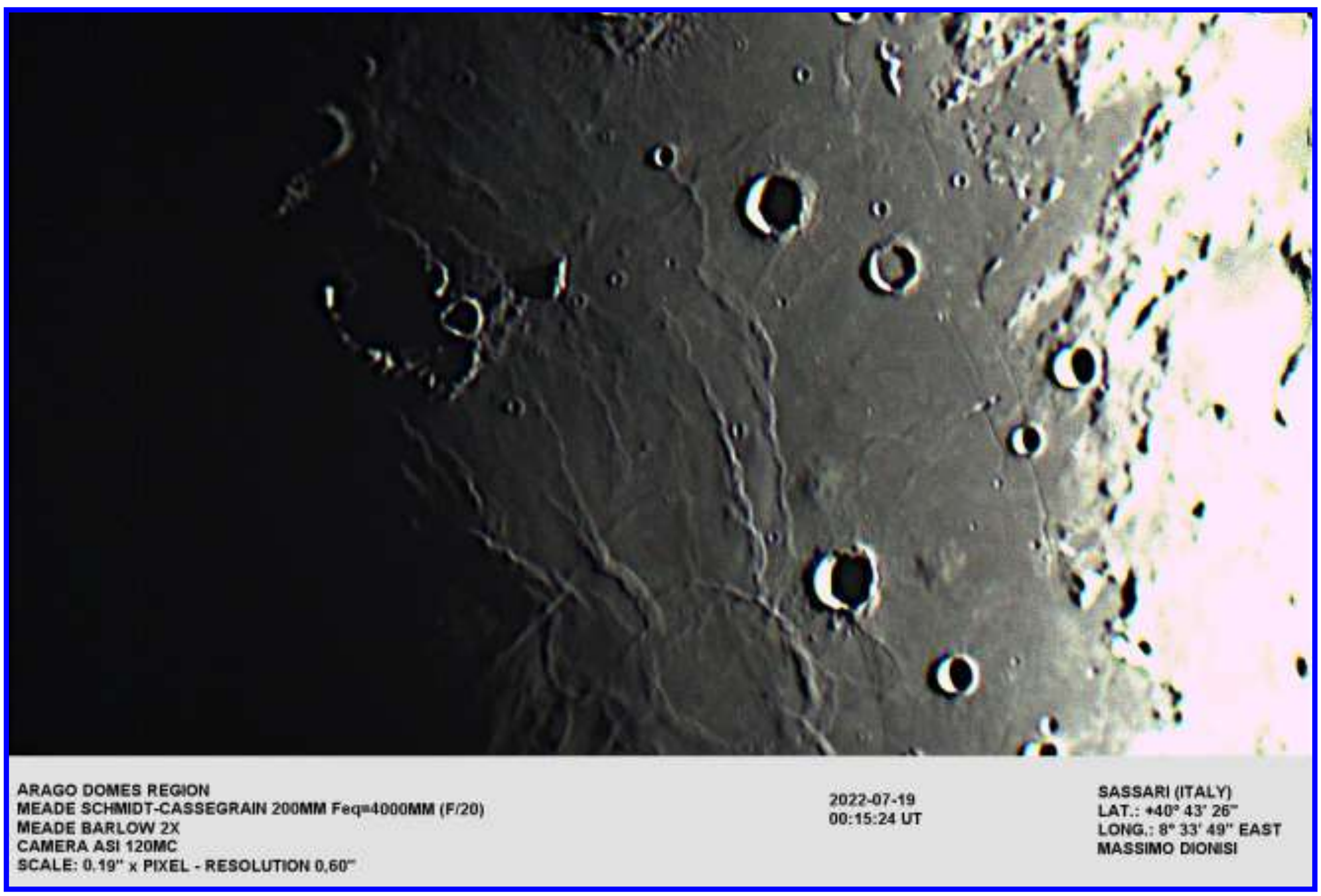
Cleomedes, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:04 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

First Quarter Moon, *Jario Chavez, Popayán, Colombia. 2022 July 07 02:30 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

Censorinus, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 08 03:00 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Arago, *Massimo Dionisi, Sarrari, Italy. 2022 July 19 00:15 UT. 8 inch Meade Schmidt-Cassegrain telescope, 2x barlow, ASI 120MC camera. North is up, west is right.*

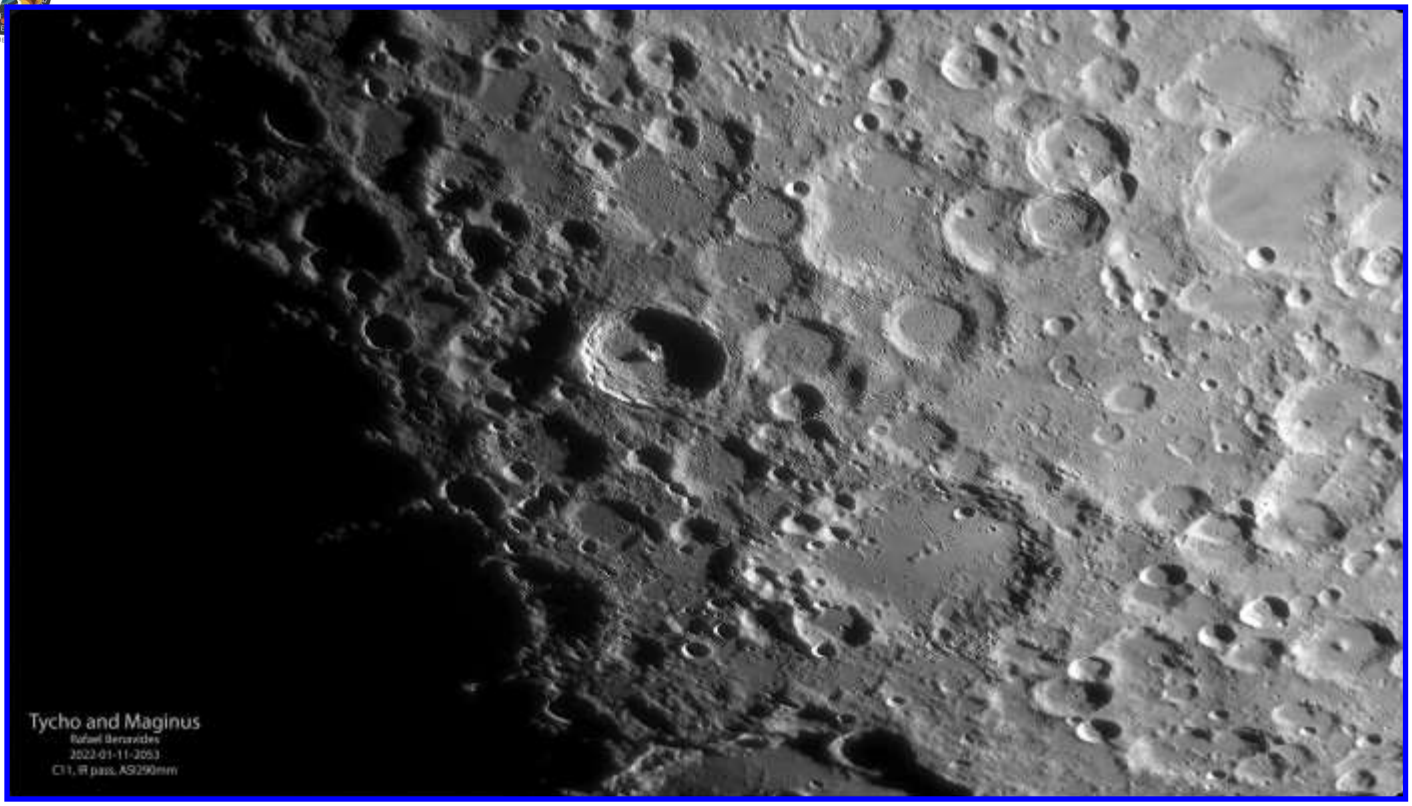


Recent Topographic Studies

Theophilus, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:09 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

Linné, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 08 03:10 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Recent Topographic Studies

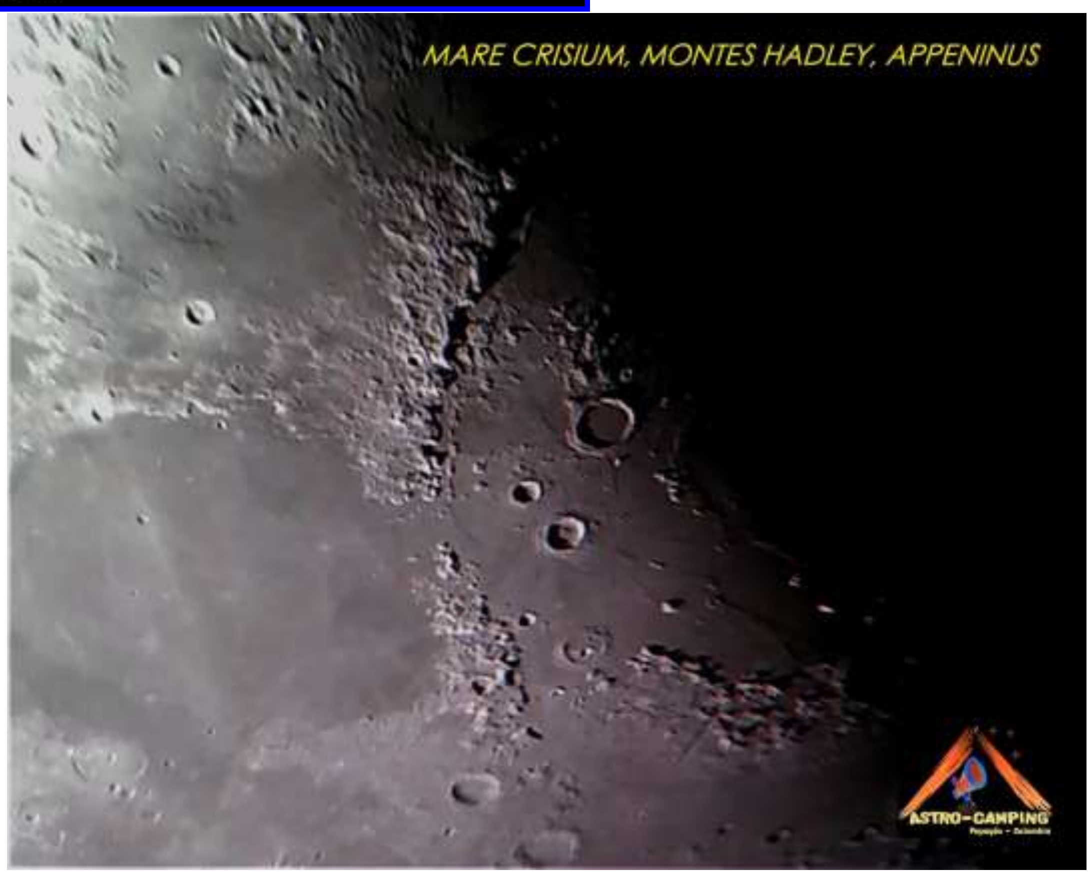


Tycho and Maginus, *Rafael Benavides, Posadas Observatory MPC J53, Córdoba, Spain. 2022 January 11 20:53 UT. Celestron 11 inch Schmidt-Cassegrain telescope, IR Pass Baader Planetarium filter, ZWO ASI290 mm camera. Seeing 7/10, transparency 5/6.*

Posidonius, *Fabio Verza, SNdR, Milan, Italy. 2022 July 16 03:12 UT. Meade 12 inch Schmidt-Cassegrain telescope, Astronomik IR 807 filter, ZWO ASI290mm camera.*

Recent Topographic Studies

Clavius, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:21 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*



Mare Serenitatis, Mons Hadley, Montes Apenninus, *Jario Chavez, Popayán, Colombia. 2022 July 07 02:42 UT. 311 mm reflector telescope, MOTO E5 PLAY camera. North is to the lower right, west is to the upper right.*

Recent Topographic Studies

Copernicus, *Maurice Collins, Palmerston North, New Zealand, 2022 July 08 05:50 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

Linné, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 08 03:15 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Recent Topographic Studies

***Copernicus,** Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 09 20:56 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

***Sinus Iridum,** Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:08 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

Recent Topographic Studies

Copernicus, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:36 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Waxing Gibbous Moon, 94%, *Jario Chavez, Popayán, Colombia. 2022 July 12 00:23 UT. 311 mm reflector telescope, MOTO E5 PLAY camera. North is to the left, west is down.*

Recent Topographic Studies

Bullialdus, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:18 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

Manilius, *Massimo Dionisi, Sarrari, Italy. 2022 July 20 01:10 UT. 8 inch Meade Schmidt-Cassegrain telescope, 2x barlow, ASI 120MC camera. North is up, west is to the right.*

Recent Topographic Studies

Anaximander, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 09 21:09 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Copernicus, *Jario Chavez, Popayán, Colombia. 2022 July 09 01:30 UT. 311 mm reflector telescope, MOTO E5 PLAY camera. North is to the left, west is down.*

Recent Topographic Studies

Montes Apenninus, *Fabio Verza, SNdR, Milan, Italy. 2022 July 09 20:51 UT. Meade 12 inch Schmidt-Cassegrain telescope, IR block filter, QHY5III462C camera.*

Plato, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 09 20:55 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Recent Topographic Studies

Mare Humboldtianum, *Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:11 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Mare Serenitatis, Mons Hadley, Montes Apenninus, *Jario Chavez, Popayán, Colombia. 2022 July 07 02:42 UT. 311 mm reflector telescope, MOTO E5 PLAY camera. North is to the left, west is down.*

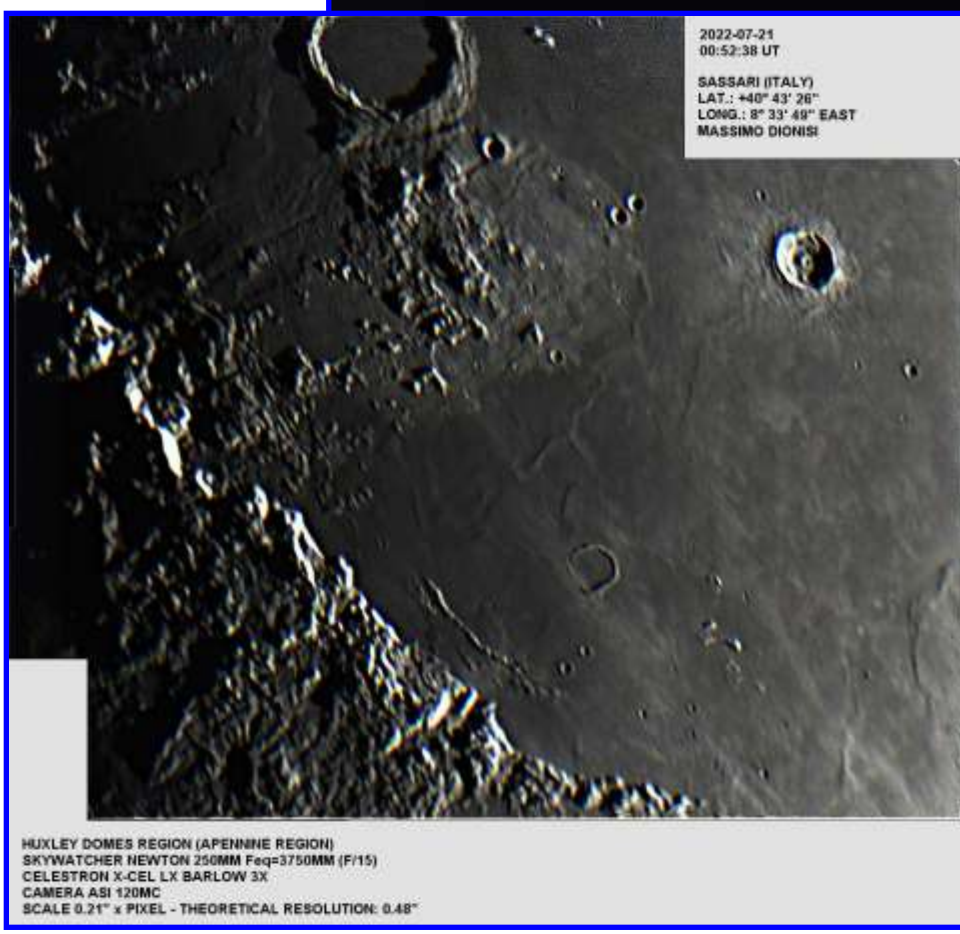
Recent Topographic Studies

Tycho, *Fabio Verza, SNdR, Milan, Italy. 2022 June 11 20:57 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Aristillus, *Massimo Dionisi, Sarrari, Italy. 2022 July 20 01:46 UT. 8 inch Meade Schmidt-Cassegrain telescope, 2x barlow, ASI 120MC camera. North is up, west is to the right.*

Recent Topographic Studies

Waxing Crescent Moon, *Jario Chavez, Popayán, Colombia. 2022 July 07 02:29 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

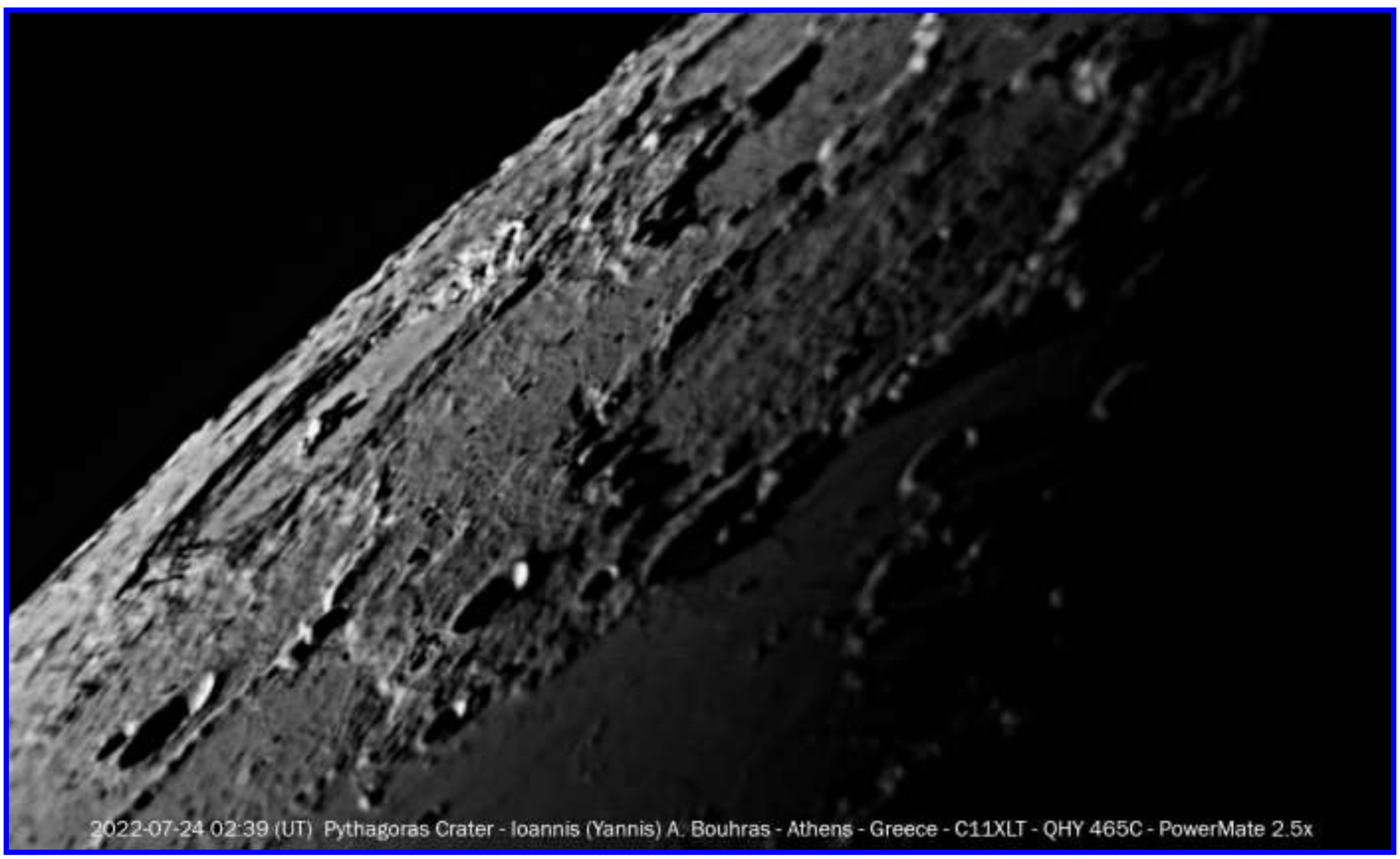


Huxley, *Massimo Dionisi, Sarrari, Italy. 2022 July 21 00:52 UT. 10 inch Skywatcher Newtonian reflector telescope, 3x barlow, ASI 120MC camera. North is up, west is to the right.*

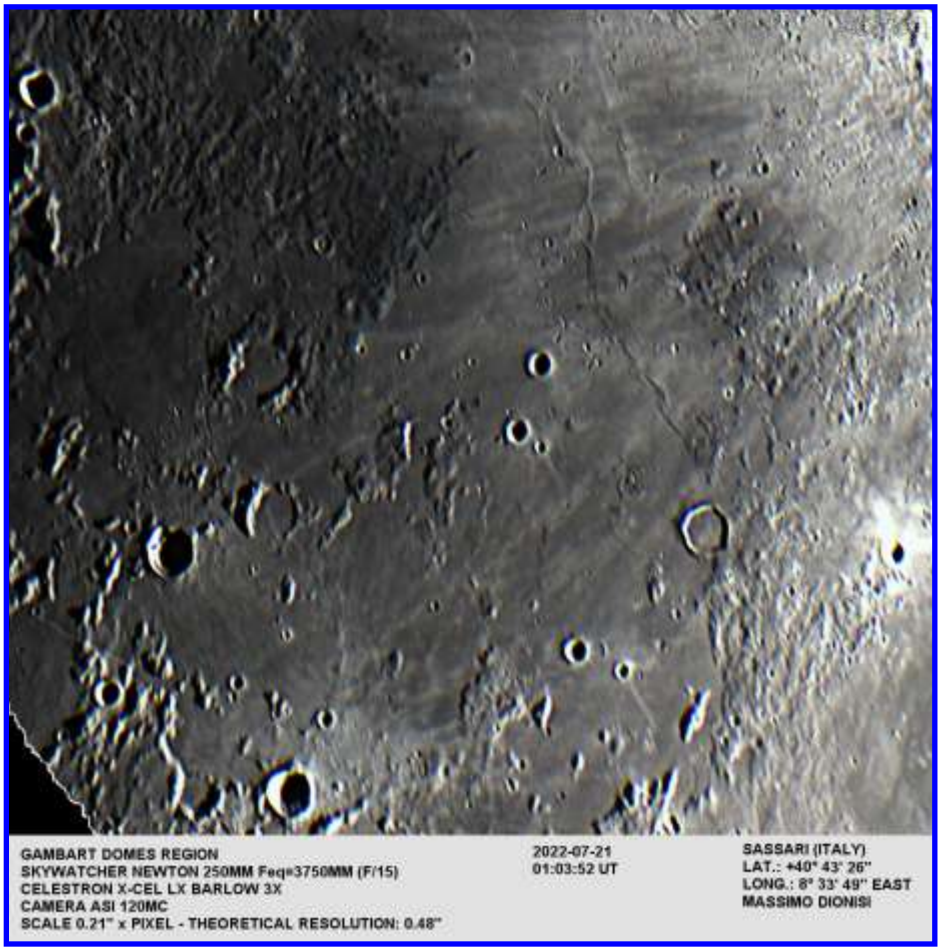
Recent Topographic Studies

Hyginus, *Massimo Dionisi, Sarrari, Italy. 2022 July 20 01:16 UT. 8 inch Meade Schmidt-Cassegrain telescope, 2x barlow, ASI 120MC camera. North is up, west is to the right.*

Pythagoras, *Ioannis (Yannis) A. Bouhras, Athens, Greece. 2022 July 24 02:39 UT. Celestron 11 inch XLT Schmidt-Cassegrain telescope, PowerMate 2,5 x, QHY465C camera.*



Recent Topographic Studies



Gambart, *Massimo Dionisi, Sarrari, Italy. 2022 July 21 01:21 UT. 10 inch Skywatcher Newtonian reflector telescope, 3x barlow, ASI 120MC camera. North is up, west is to the right.*

Schickard, *Ioannis (Yannis) A. Bouhras, Athens, Greece. 2022 July 24 02:32 UT. Celestron 11 inch XLT Schmidt-Cassegrain telescope, PowerMate 2,5 x, QHY465C camera.*

Recent Topographic Studies

Vallis Schröteri, *Ioannis (Yannis) A. Bouhras, Athens, Greece. 2022 July 24 02:37 UT. Celestron 11 inch XLT Schmidt-Cassegrain telescope, PowerMate 2,5 x, QHY465C camera.*

Lunar South Pole*, David Teske, Louisville, Mississippi, USA. 2022 February 12 02:25 UT, colongitude 36.2o. 4 inch f/15 refractor, IR block filter, ZWO ASI120mm/s camera. Seeing 8/10.*

Recent Topographic Studies

14 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 July 13 07:50-09:03 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

Gauss, *Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:13 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Recent Topographic Studies

Proclus, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 09 20:53 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Nansen, *Fabio Verza, SNdR, Milan, Italy. 2022 July 13 22:18 UT. Celestron 6 inch Schmidt-Cassegrain telescope, iOptron CEM70G mount, IR block filter, QHY5III462C camera.*

Recent Topographic Studies

Bullialdus, *Maurice Collins, Palmerston North, New Zealand, 2022 July 08 05:49 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*

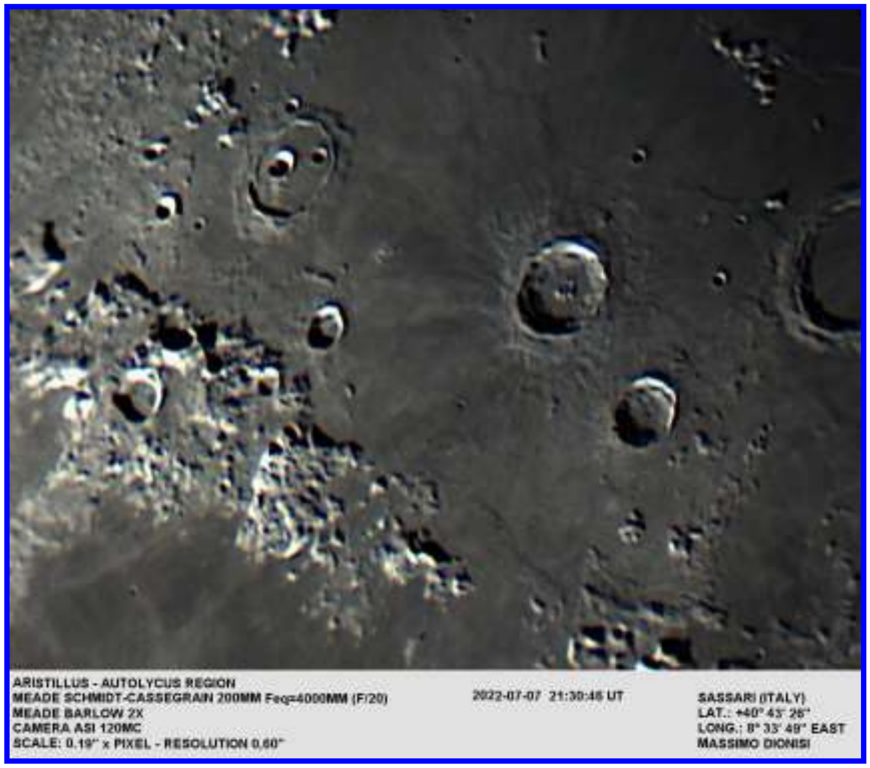
Stevinus A, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 09 21:01 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Recent Topographic Studies

Waxing Gibbous Moon, 71%, *Jario Chavez, Popayán, Colombia. 2022 July 09 00:20 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies

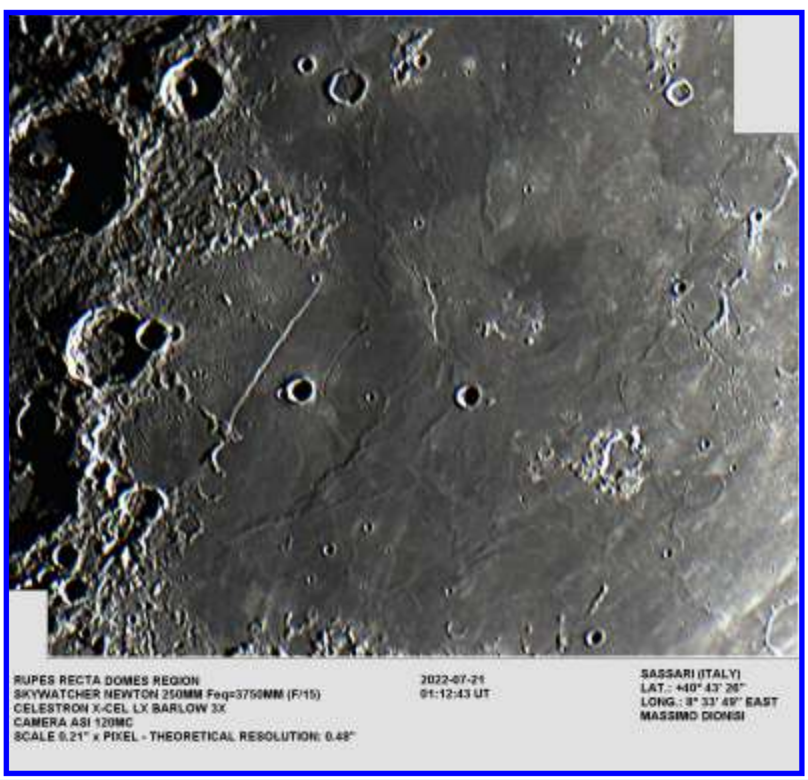
Aristillus, *Massimo Dionisi, Sarrari, Italy. 2022 July 07 21:30 UT. 8 inch Meade Schmidt-Cassegrain telescope, 2x barlow, ASI 120MC camera. North is to the upper left, west is to the upper right.*



Aristarchus, *Walter Ricardo Elias, Oro Verde, Argentina. 2022 July 12 23:01 UT. 114 mm Helios reflector telescope, QHY5-IIC camera.*

Recent Topographic Studies

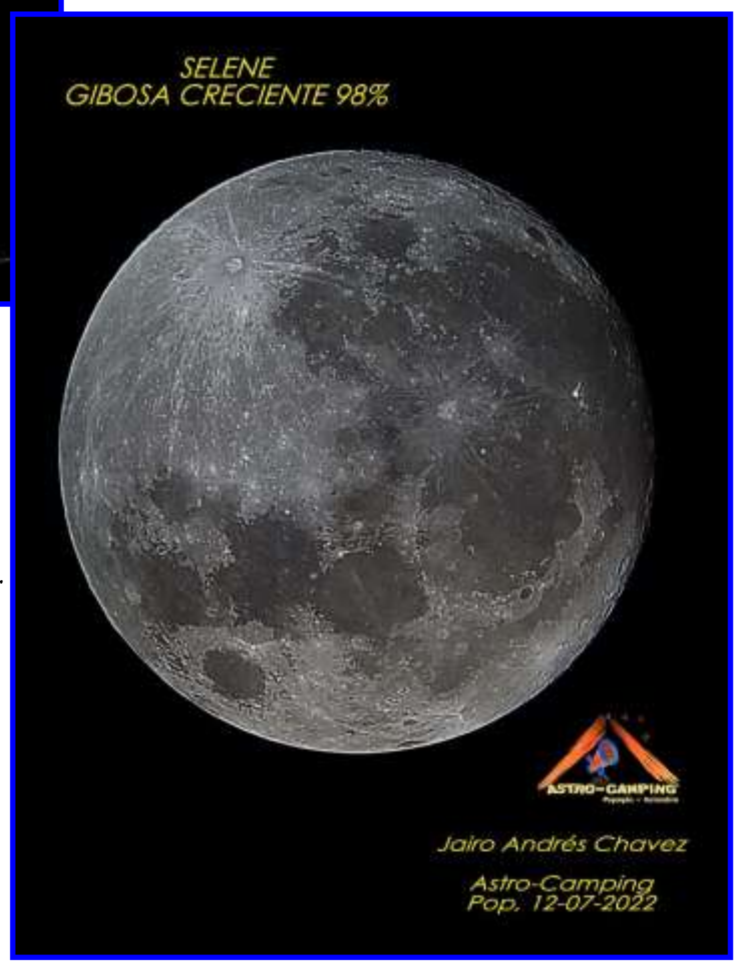
Waxing Gibbous Moon, 81%, *Jario Chavez, Popayán, Colombia. 2022 July 09 23:00 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*



Rupes Recta, *Massimo Dionisi, Sarrari, Italy. 2022 July 21 01:12 UT. 10 inch Skywatcher Newtonian reflector telescope, 3x barlow, ASI 120MC camera. North is up, west is to the right.*

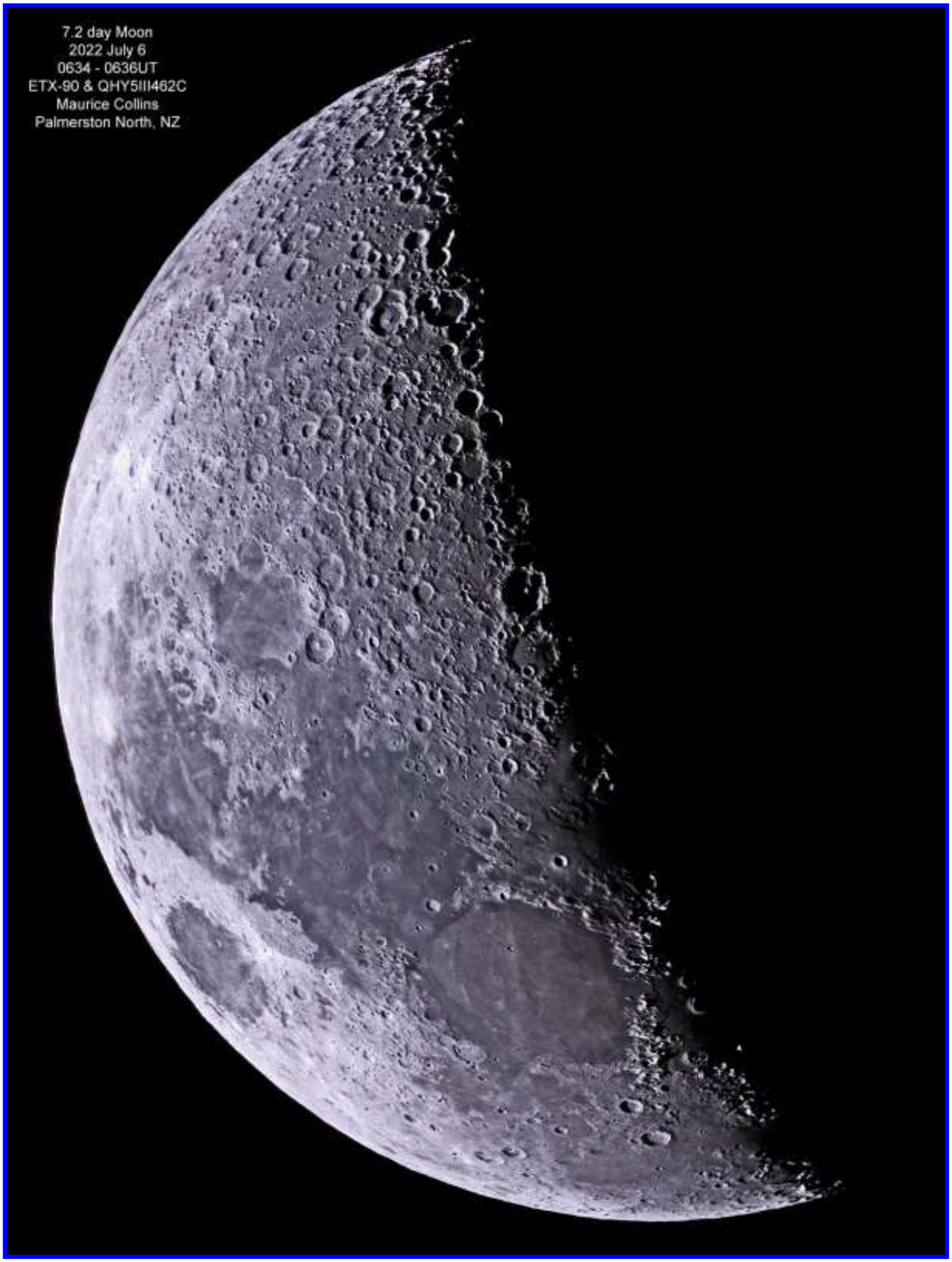
Recent Topographic Studies

5.1 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 July 04 05:43 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera.*



Waxing Gibbous Moon, 98%, *Jario Chavez, Popayán, Colombia. 2022 July 13 01:54 UT. 311 mm reflector telescope, MOTO E5 PLAY camera.*

Recent Topographic Studies



5.2 day old Moon, *Maurice Collins, Palmerston North, New Zealand, 2022 July 06 06:34-06:36 UT. Meade ETX-90 Maksutov-Cassegrain telescope, QHY5III462C camera. Maurice adds:*

Recent Topographic Studies

Lunar Geologic Change Detection Program

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

2022 August

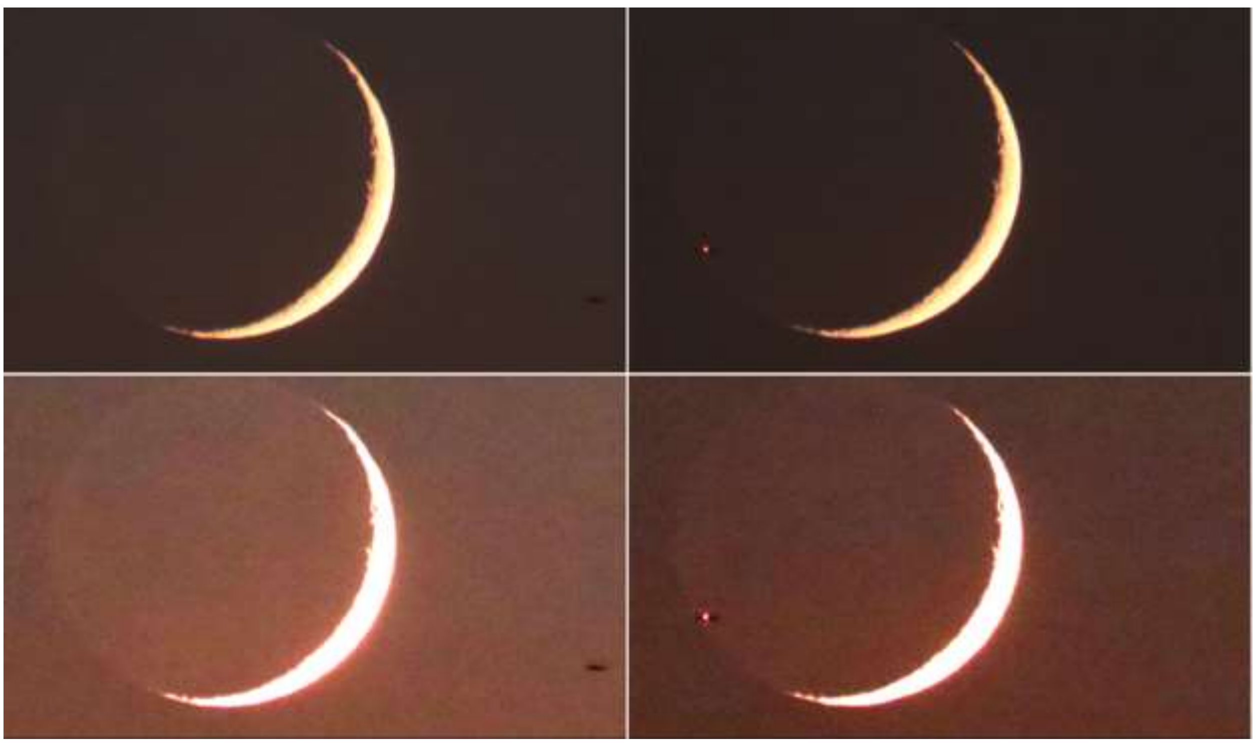


Figure 1. *The Moon as captured by Malcom Porter on 2022 Jul 01 UT 21:49. Top images are two images taken close together in time. The bottom images have been contrast stretched.*

LTP reports: No reports were received for July, though a curious image was submitted by Malcolm Porter (Kent, UK) of a red flash on the Moon's SW limb (See Fig 1 – top right). An adjacent reference image can be seen in Fig 1 (Top Left), without any flash of light. Lunar impact flashes can sometimes be red in color, especially if they are low temperature impacts. However, investigation soon revealed, after a bit of contrast enhancement, that the flash was just a navigation light from an aircraft (Fig 1 – bottom right), and the aircraft itself appeared in silhouette, against the sky, on an adjacent frame (Fig 1 – bottom left). Readers should be on the lookout for this effect as it is quite frequent at small lunar phases, when the Moon is a crescent and low down near the horizon. What is happening here is that we are looking though a much longer path length of atmosphere, near the horizon, so there is more chance of aircraft, birds, satellites etc., being caught flying past the line of sight to the Moon.

Routine Reports received for June included: Alberto Anunziato (Argentina – SLA) observed visually: Aristarchus, Langrenus, Mare Crisium, and Torricelli B. Maurice Collins (New Zealand – ALPO/BAA/ RASNZ) imaged: Clavius, Delambre, Gassendi, Mare Serenitatis, Plato, Theophilus and several features. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine and the dayside of the Moon in visible light, SWIR (1.1-1.7 microns), and also in the thermal IR (7.5-15 microns). Valerio Fontani (Italy – UAI) imaged: earthshine. Les Fry (West Wales, UK – NAS) imaged: Aliancensis, Cassini, Catena Abulfeda, Curtius, Hipparchus, Manilius, Rimae Theaetetus, Stofler, Triesnecker and Werner. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Linne and Rupes Recta. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Langrenus, Messier, Plato, and Proclus. Franco Taccogna (Italy – UAI) imaged earthshine. Aldo Tonon (Italy – UAI) imaged: Aristarchus, Copernicus and Hermann D. Luigi Zanatta (Italy – UAI) imaged Aristarchus.

Analysis of Reports Received:

Earthshine: On 2022 Jun 01 UAI observers Valerio Fontani and Franco Taccogna took up the following lunar schedule challenge:

BAA Request: Please try to image the Moon as a very thin crescent, trying to detect earthshine. A good telephoto lens will do on a DSLR, or a camera on a small scope. We are attempting to monitor the brightness of the edge of the earthshine limb in order to follow up a project suggested by Dr Martin Hoffmann at the 2017 EPSC Conference in Riga, Latvia. This is quite a challenging project due to the sky brightness and the low altitude of the Moon. Please do not attempt if the Sun is still above the horizon. Do not bother observing if the sky conditions are hazy. Any images should be emailed to: a t c @ a b e r . a c . u k

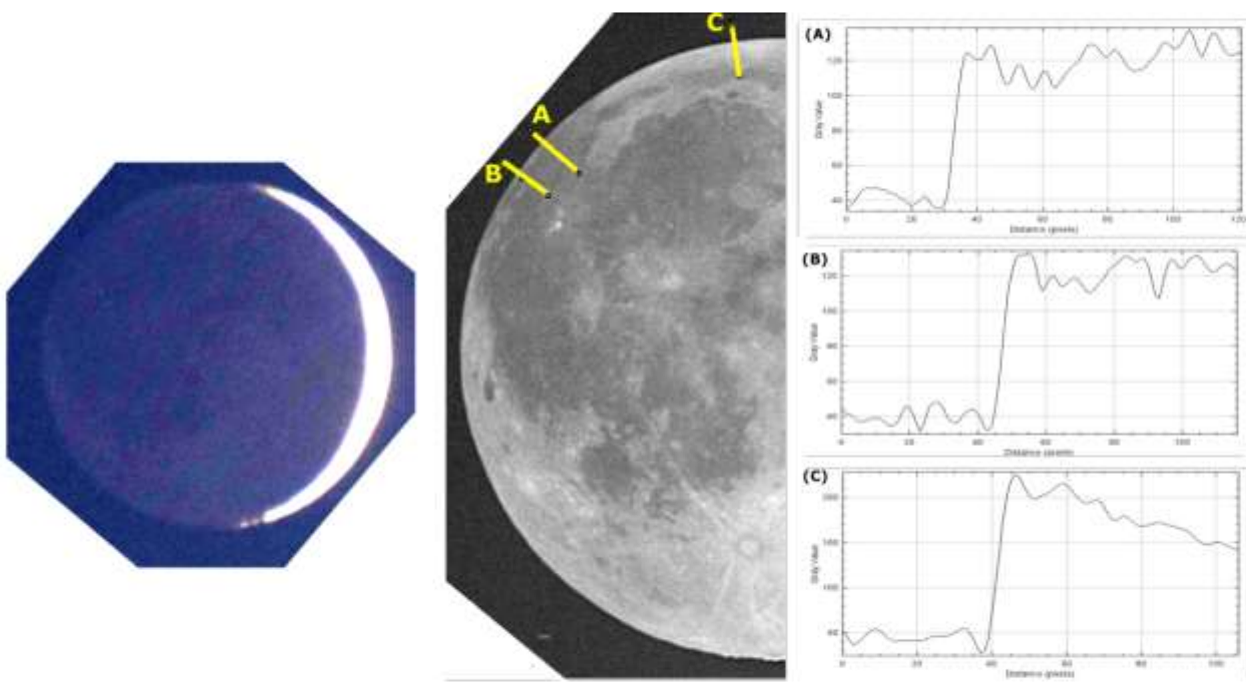


Figure 2. *Earthshine observations made UAI observers on 2022 Jun 01 with north orientated towards the top.* ***(Left)*** *Image by Valerio Fontani at UT 19:38.* ***(Center)*** *Image by Franco Taccogna at 19:43 UT with three brightness cross sections: A,B,C.* ***(Right)*** *Corresponding brightness cross sectional profiles for A,B and C.*

The idea behind Prof Hoffmann's conjecture is that when the Sun is almost behind the Moon – as close as to New Moon as is observationally possible, then if there were any dust clouds above the lunar surface (suspended electrostatically or due to impact ejecta) then right on the limb of the Moon, on the night side, you might be able to detect forward scattering of the sunlight, just over on the far side. This should result in a light arc around the earthshine limb. Fig 2 (Left), taken by Aldo in twilight, shows no obvious arc around the limb, nor at first does Franco's longer exposure image (Fig 2 – Center). However, if we look again at Fig 2 (Center) and examine the three cross-sectional brightness profiles on the right of Fig 2, there is slight evidence for blips (local maxima) in brightness going from the blackness of space to the earthshine. – these might infer a light arc around the limb?

Now, before we get too excited, a couple of points that might offer simpler explanations. (1) It is possible that either in the software, or the CCD camera electronics, some sharpening may have occurred, and as a result one gets "ringing" effects on dark/bright boundaries, giving a faint light arc around the limb of the Moon. (2) Certainly, on the NW limb of the Moon there is a bright highland area on the far side which sometimes comes into view with appropriate libration – so it is possible the slightly brighter limb we are seeing in brightness profiles A and B could be from this?

So how could we tell the difference? Well, if the dust cloud was present, and at an altitude of a km or more, then the arc would be slightly outside, and not inside the limb of the Moon. Secondly, time lapse imaging might reveal some changes over time, especially near more dusty areas of the Moon. Thirdly, the effect may be strongest at higher latitudes as the light has more chance of being near grazing incidence here, especially at the poles – but we also have to be careful of topography here which sticks out above the terminator. So, more work needs to be done on this observational method, especially time lapse imaging. If anybody is interested in reading Prof Hoffmann's 2017 EPSC abstract then click here.

Mutus F: On 2022 Jun 04 UT 05:27-05:31 Maurice Collins (ALPO/BAA/RASNZ) captured a Lunar Schedule request of this crater:

BAA Request: Can you see, or image, 4 points of light in the shadowed floor of the crater? How do these change in appearance over time? Please send any images, or sketches, to: a t c @ a b e r. a c. u k

This actually refer to a report by Robert Spellman:

`On 2005 Jan 15 at UT 01:25 R. Spellman (Los Angeles, CA, USA, 8" reflector) observed 4 bright points of light on the crater Mutus F? - see Rukl Atlas page 175, chart 74. If his identification of the crater was correct then he could see no structures in the crater that would yield this effect. It could well be that the 4 bright points are just 4 high peaks on the rim catching the first rays of the Sun.`

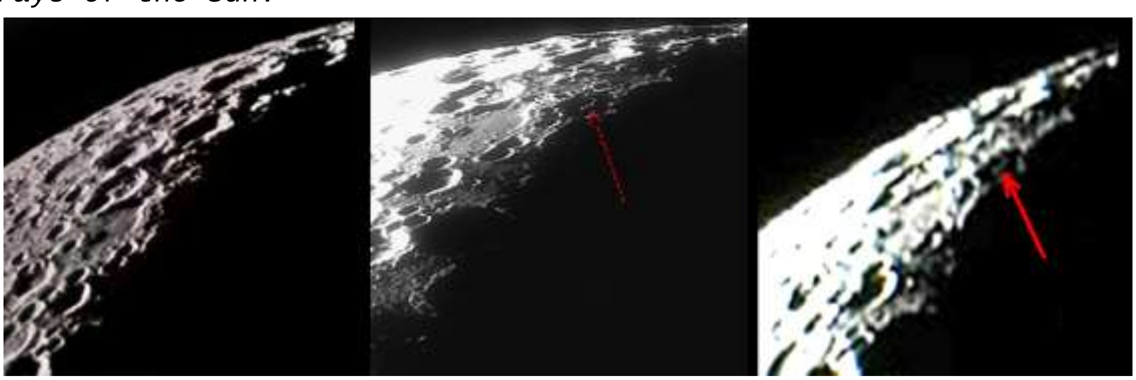


Figure 3. *The Moon in the vicinity of Mutus F and orientated with south at the top.* ***(Left)*** *An image by Maurice Collins taken on 2022 Jun 04 UT 05:27-05:31.* ***(Center)*** *An image by Robert Spellman taken on 2005 Jan 15 UT 01:25 with an arrow indicating a "sting of pearl" effect.* ***(Right)*** *An image by Maurice Collins from 2011 Sep 02 UT 08:49-09:07 with an arrow locating where the "string of pearls" effect would be.*

Maurice's image (Fig 3 - Left), taken in 2022 does not show any illuminated region compared to the original image (Fig 3 - Center) by Robert Spellman, hence was slightly too early in terms of sunrise conditions. However, looking through the archives, he did image the area on 2011 Sep 02 (Fig 3 – Right) and certainly record an illuminated area where Robert Spellman detected his string of bright spots. In fact, we have already covered this in the 2020 May newsletter and eliminated it as a LTP, but had yet not removed it from the Lunar Schedule program – as we were interested to see how these spots developed. Maurice's 2022 image puts a constraint on one end of the selenographic colongitude range, and this has now been updated in the Lunar Schedule program.

Aristarchus: On 2022 Jun 04 UT 22:45-22:50 Alberto Anunziato (Argentina – SLA) observed visually this area under a similar lunar phase to the following report:

On 1975 Dec 08 at UT18:00-20:40 P.W. Foley (Wilmington, Kent, UK, 12" reflector, x60-x624, seeing II, slight mist) found Aristarchus to be less well visible than features such as: Grimaldi, Reiner, Darwin/Byrgius, Kepler, Plato and Sinus Iridum. Earthshine was exceptionally good tonight and was orange/red in color. Photographs were taken and these confirmed the apparent dullness of Aristarchus. ALPO/BAA weight=2.

Alberto, using a 105 mm. Maksutov-Cassegrain (Meade EX 105, magnification x154) commented that Aristarchus was on the night side and could not be seen in earthshine, only the outline of the mare edges. Although Aristarchus is often bright in earthshine, when the libration is right, and less earth-lit illuminated slopes are facing away from us, it can appear darker. We shall leave the weight at 2 for now.

Alpetragius: On 2022 Jun 08 UT 04:10 Rik Hill (ALPO/BAA) was imaging the Rupes Recta area, but just caught the southern end of Alpetragius crater, under similar illumination to the following report:

Alpetragius 1958 Nov 19 UT 22:00-22:05 Observed by Stein (Newark, New Jersey, USA, 4" refractor) "Shadow anomaly. Portion of shadow vanished, replaced by lighter shade. At 22:05 gradually darkened & was normal in 20 sec." NASA catalog weight=3. NASA catalog ID #704. ALPO/BAA weight=2.

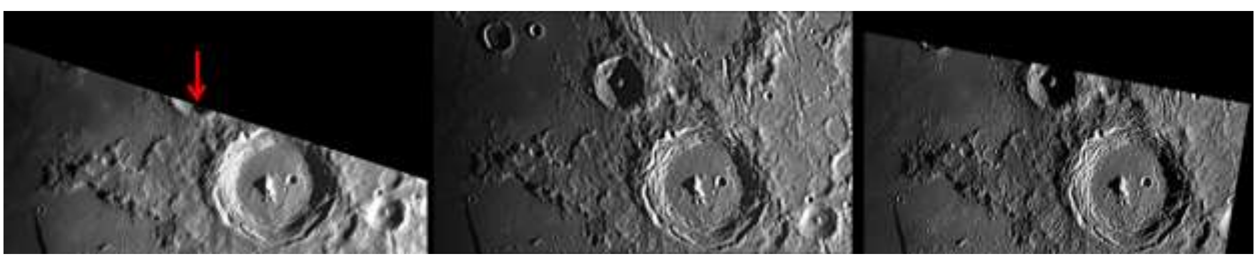


***Figure 4.** Alpetragius orientated with north towards the top. **(Left)** An image by Rik Hill, taken on 2022 Jun 08 UT 04:10. The image has been rotated and Alpetragius is just on the edge, as indicated by the red arrow. **(Center)** An image by Brendan Shaw (BAA), taken under similar illumination on 2015 Jan 28 UT 20:12. **(Right)** An image by Mike Brown (BAA), taken under similar illumination, on 2009 Apr 03 UT 18:43.*

This crater has four LTP associated with it, three of which were by Barnard in 1889 concerning: *"Shadow of CP diffused & pale. Entire inside of crater seemed filled with haze or smoke"*, and the fourth by Stein in 1958, again shadow related. As is often the case, when observations are submitted to me, they are either of a specific lunar feature from the LTP predictions/lunar schedule web sites, or are just for reference and may contain the whole feature of interest or perhaps just part. The latter is the case for Rik's image (Fig 4 – Left). Nevertheless, it is useful in that we can see that everything looked normal in the southern part of the shadow captured in 2022. Looking for similar illumination images from the past, we have an image by Brendan Shaw from seven and a half years ago (Fig 4 – Center) and an even earlier image by Mike Brown (BAA) from more than 13 years ago. None of these can be said to show anything unusual in the shadow. The Barnard observations were made with a sizable 36" telescope at Lick observatory. The 1958 LTP observation was made with a smaller 4" refractor, and was relatively short in duration. We should certainly keep a watch on this crater over selenographic colongitude ranges of 13° to 25°, which covers the span of those past four LTP – this should include visual observations, as well as CCD, in case the effect is seeing related? The ALPO/BAA LTP weight will be increased from 2 back up to 3.

Plato: On 2022 Jun 08 UT 21:25-21:40 Trevor Smith (BAA) observed visually this crater a few minutes after a ±1° similar illumination and topocentric libration to the following report:

Plato 1932 Apr 15 UT 06:57 Observed by A.V. Goddard & friend (Portland, Oregon, USA, 16" telescope, S=G steady) "Sudden appearance of a white spot like a cloud of steam (in appearance only), and in less than a minute it had spread in a NW direction, until it almost reached the rim of the crater" NASA catalog weight=4. NASA catalog ID #403. ALPO/BAA weight=4.

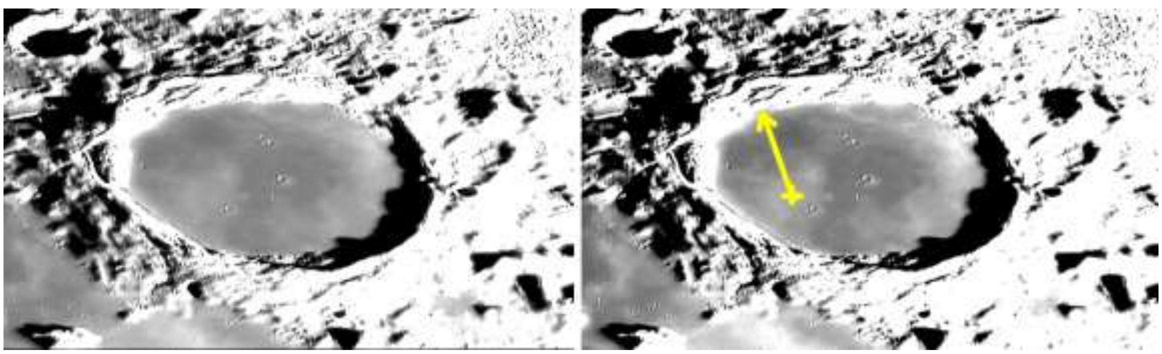


***Figure 5.** Plato as imaged by Maurizio Cecchi (UAI) on 2014 Nov 02 UT 17:35 and orientated with north towards the top and slightly to the right. **(Left)** The original image but contrast stretched to bring out detail on the floor. **(Right)** The same image but with a cross added to show the location of the 1932 sudden white spot, and an arrow to indicate the approximate direction of travel of the expanding cloud.*

Trevor (BAA) was also using a 16" reflector and commented: *"...observed visually this crater under similar illumination and topocentric libration to the following report "I looked and just saw the central craterlet as a whitish 'spot'. Some 20 km to the west was a whitish smudge which came and went with the seeing (Ant IV). No other detail was visible on the floor of Plato and I think it was simply one of the normal whitish patches which are usually present!"*. The reason why the 1932 report was given an ALPO/BAA weight of 4 was because two observers were involved, the scope was large (like Trevor's), the seeing was good, no other craterlets were seen on the floor, there was a sudden change and the effect expanded until it reached the rim of Plato. Just for reference, Fig 5 (Left) is a similar illumination image, a few minutes outside the ±0.5° observing widow predictions. This certainly shows some light albedo markings which could give the impression of cloud on the floor of the crater, but the sudden appearance and cloud expansion are not normal. The original report by Goddard, published in the 1932 edition of Popular Astronomy, vol 40, p316, actually gives a coordinate of the appearance of the white spot at 10°W, 51°N, and assuming the distance to the rim was 50 km (See Fig 5 – Right) and "less than .a minute" could be anything from 30 sec to 59 sec, then the velocity of the cloud would have been anywhere from 0.8 to 1.7 km/s.

So, what I am wondering here is whether this was a glancing blow impact from the south east, and then the expansion of the ejecta cloud on a north westerly direction? If so, it may be difficult to find the crater without a before and after image, but possible candidates would be elongated or double, have rocky rims, and may show an ejecta pattern towards the NW though this would probably be very subtle and you might want to divide two images of the same area at different phases in order to enhance this?

Aristarchus: On 2022 Jun 10 UAI observers: Aldo Tonon and Luigi Zanatta imaged this crater for the following Lunar Schedule request:

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

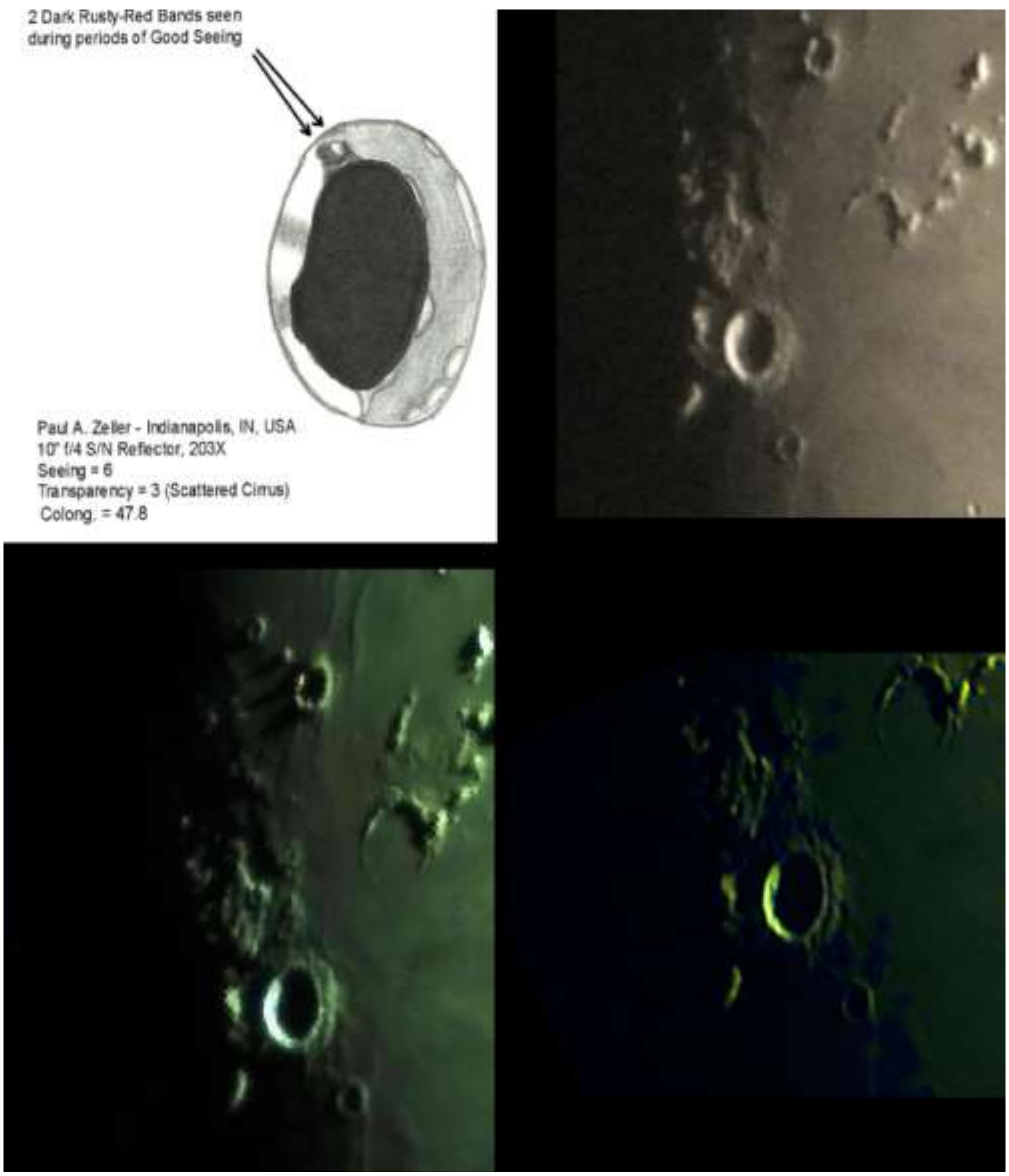


Figure 6. *Aristarchus orientated with north towards the top.* ***(Top Left)*** *A sketch by Paul Zeller from 2013 Apr 22 UT 01:43. The text on this sketch has been re-orientated to comply with north towards the top.* ***(Top Right)*** *An image by Paul Zeller made on 2013 Apr 22 UT 02:37 with color saturation increased to 60%.* ***(Bottom Left)*** *An image by Luigi Zanatta (UAI) made on 2022 Jun 10 UT 22:35 with color saturation increased to 60%.* ***(Bottom Right)*** *An image by Aldo Tonon (UAI) made on 2022 Jun 10 UT 22:59 with color saturation increased to 60%.*

As we can see from Paul Zeller's sketch (Fig 6 – Top Left), the rusty red bands sit on the NW rim on the border between the illuminated rim and the shaded north rim. Alas Paul's attempt to capture these in an image did not succeed as the resolution was not good enough. Luigi and Aldo have since tried, with higher resolution, under similar illumination, but again the resolution is not quite enough to detect the rusty red color here – assuming it was natural? This is despite having the color saturation in their images increased. We shall leave the weight of this observation at 1 for now. This LTP has been covered in previous newsletter in: 2013 Jun, 2017 May, 2018 Oct, 2021 Jan and 2021 Mar.

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

The Werner-Airy Basin

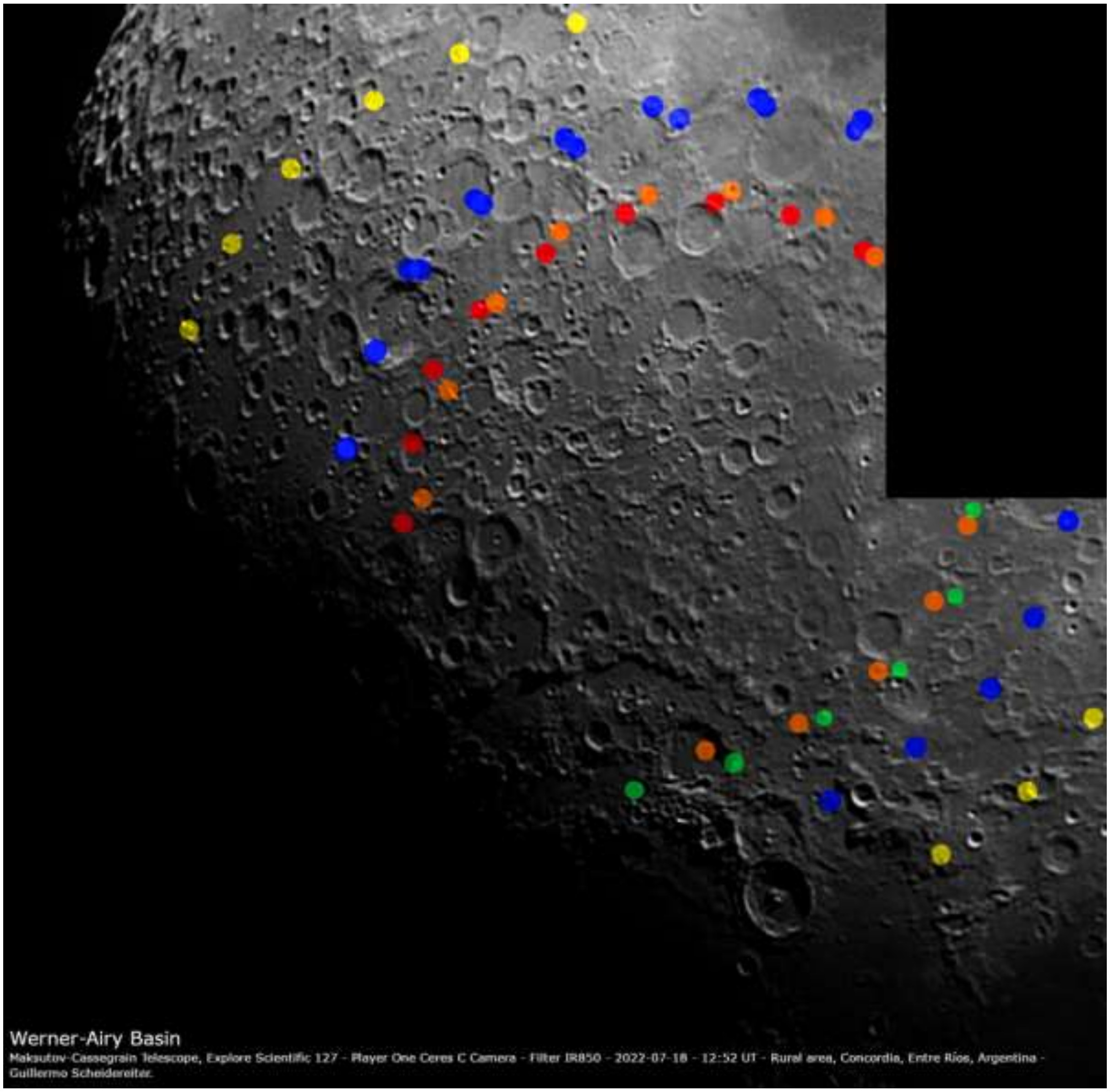


Figure 1. *The Werner-Airy impact basins with three proposed rings added by Guillermo Daniel Scheidereiter (LIADA). Note that they had two attempts at estimating the primary and secondary rings, hence the different coloured dots or dot positions. The inner rim is red/green. The second rim is blue and the third rim is yellow.*

I was grateful to receive our very first attempted estimate of the basin rings for the Werner-Airy impact basin, from Guillermo Daniel Scheidereiter in Argentina, using an image that they had taken in July. Guillermo had two attempts at estimating the primary and secondary ring, which I have combined in Fig 1. By reverse engineering these to find the longs and lats of each dot, using the NASA LROC Quickmap web site, I was able to estimate the ring diameters to be: 688±17 km, 1028±89 km, and 1357±50 km. This is at odds though with the values listed by *Liu et al.* (2015), who give 350, 515 and 765 km diameter rings. Guillermo's 688 ±17 km diameter ring is the closest to the Liu *et al.* ring diameter of 765 km, and so if my standard deviation estimate was off (it was based upon just 4 transects across the basin), then these maybe one and the same ring? Looking at Fig 1 there is a hint of the two inner rings that Liu *et al.* mention, though the inner one is more of a circular patch of cratered terrain? Another point to mention is that lunar geology text books say that impact basin ring radii increase in size by √2 – neither Guillermo or the Liu *et al.* ring diameters seem to follow this rule – though it may be a rule of thumb rather than a precise relationship?

So, as you can see estimates of basin ring diameters are very subjective and tricky. This reminded me a technique that was used many years ago in MoonZoo, namely by getting lots of people to estimate a basin or crater's rings/perimeters, one can find a mean diameter and by statistical analysis the standard deviation on these. The standard deviation can be used to give a measure of how poorly degraded the rings are. After all if a basin ring is badly damaged, people will come up with wildly different estimates of where it begins and ends. A pristine basin, like Orientale will have sharper edges, and a smaller error on estimations of the diameters of the rings.

Anyway, like last month I am showing various geophysical datasets for the Werner-Airy basin in Fig 2.

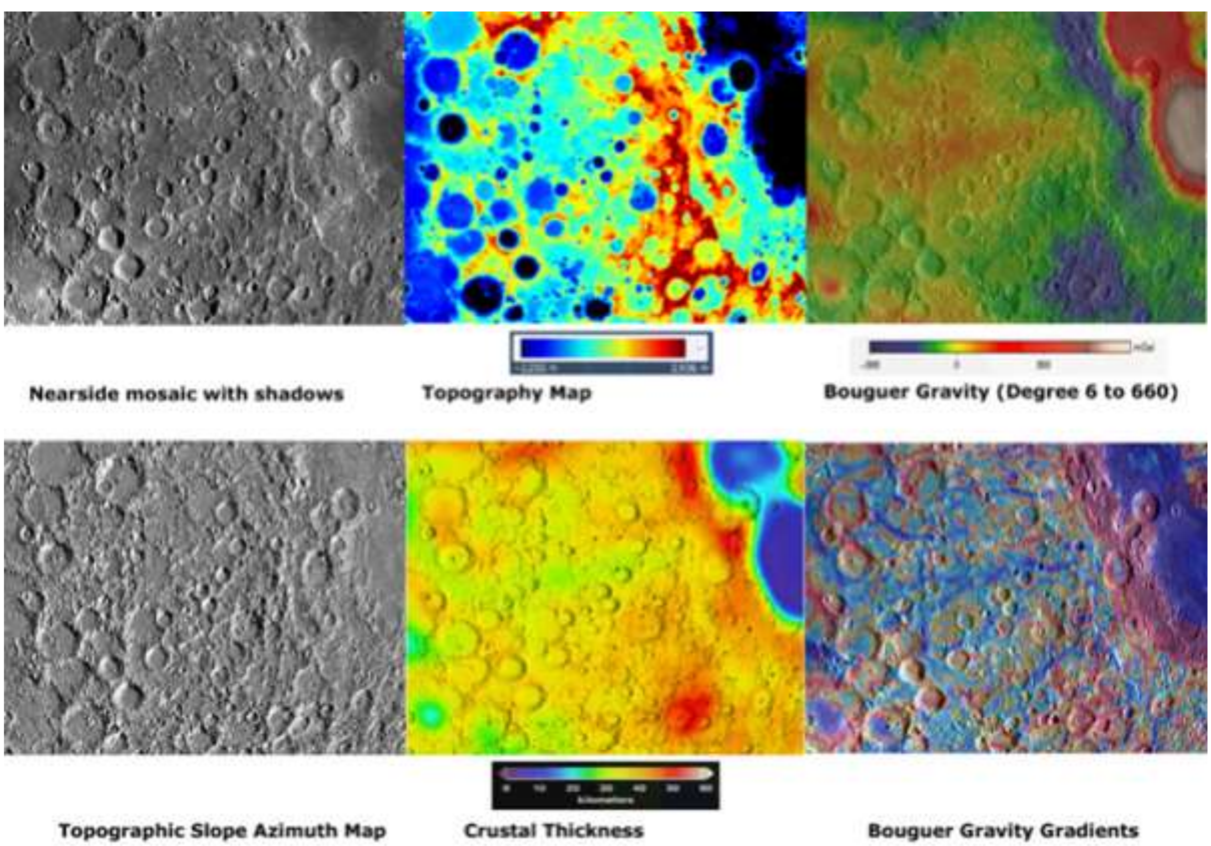


Figure 2. *Geophysical datasets for the Werner-Airy proposed impact basin.*

The topography in Fig 2 may show perhaps half of a remnant rim, as does the crustal thickness map – though it's odd that this evidence is strongest to the east, which is nearer to the destructive impact forces of the Nectarian basin. The Bouguer gravity data shows no characteristic bulls-eye effect like you get in many basins. However not all basins show this e.g., Tranquillitatis or many pre-Nectarian era basins in general. There is a very faint linear mass anomaly the travels E-W across the floor of the basin though. The slope azimuth plot is peppered with highland craters, but may show slight hints of concentric inward facing slopes – but only if you blur your eyes. The gravity gradient image shows a network of filaments where the gravity isn't changing much. These straddle the floor of Werner-Airy but less so south of the basin.

So, to sum up, this looks like Werner-Airy will be a tricky basin to prove and measure rings on. The only safe thing to say is that it is pre-Nectarian in age as the Nectaris basin geology and topography clearly sits on top of part of it. We need more shallow illumination angle imagery on the morning and evening terminators, and for others to have a go on the NASA's Quickmap, drawing out where they think the basin rims are (please provide me with some long, lat coordinates), then we can get some statistical consensus and update the database.

Please take a look at our website for other lunar impact basins and buried craters that you may want to image: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm . I am really keen to gather imagery of the less certain basins, and also for all basins and buried craters in order to find the best selenographic colongitudes to see them at sunrise and sunset.

Lunar Calendar August 2022

Date	UT	Event
4		West limb most exposed -6.6°
5	1107	First Quarter Moon
9		Greatest southern declination -27.0°
10	1700	Moon at perigee 359,828 km
12		North limb most exposed +6.5°
12	0136	Full Moon
12	0400	Saturn 4° north of Moon
14	1000	Neptune 3° north of Moon
15	1000	Jupiter 1.9° north of Moon
16		East limb most exposed +7.3°
18	1500	Uranus 0.6° south of Moon, occultation Micronesia to Iceland
19	0436	Last Quarter Moon
19	1200	Mars 3° south of Moon
22		Moon at apogee 405,418 km
23		Greatest northern declination +27.0°
25	1900	Ceres 0.7° north of Moon, occultation Polynesia
26		South limb most exposed -6.6°
27	0817	New Moon lunation 1233

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.

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 non-member 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.

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
Alberto Anunziato–albertoanunziato@yahoo.com.ar
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: Wonders of the Full Moon

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 September 2022 Focus-On will be the craters rayed craters of the Moon's southern hemisphere. In November 2022, Eratosthenes eill be the subject of the Focus-On article. 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):

Alberto Anunziato – albertoanziato@yahoo.com-ar
David Teske – david.teske@alpo-astronomy.org

FUTURE FOCUS ON ARTICLES:

In order to provide more lead time for contributors the following future targets have been selected:

Subject	TLO Issue	Deadline
Bright Rays South	**September 2022**	**August 20, 2022**
Ever Changing Eratosthenes	**November 2022**	**October 20, 2022**

Focus-On Announcement

WONDERS OF THE FULL MOON

The full moon is loved by almost everyone, except for the majority of astronomers. But when the near side is illuminated almost completely by frontal light, it is the opportunity to enjoy a unique spectacle: the bright ray craters. It is a field of study favorable to amateur observation with scientific value: how far does each bright ray reach? Are some rays brighter than others coming from the same crater? Are they altered by the relief over which they pass? And many other questions that ALPO's Bright Lunar Rays Project has as its objectives.

Bright Lunar Rays Project Objectives:
https://moon.scopesandscapes.com/ALPO%20Rays%20Project.htm

List of rayed craters and other non-crater features:
https://moon.scopesandscapes.com/alpo-rays-table.pdf

JULY 2022 ISSUE-Due **June 20th, 2022**: **NORTHERN BRIGHT RAY CRATERS**
SEPTEMBER 2022 ISSUE-Due **August 20th, 2022: SOUTHERN BRIGHT RAY CRATERS**

Leandro Sid

Focus-On Announcement

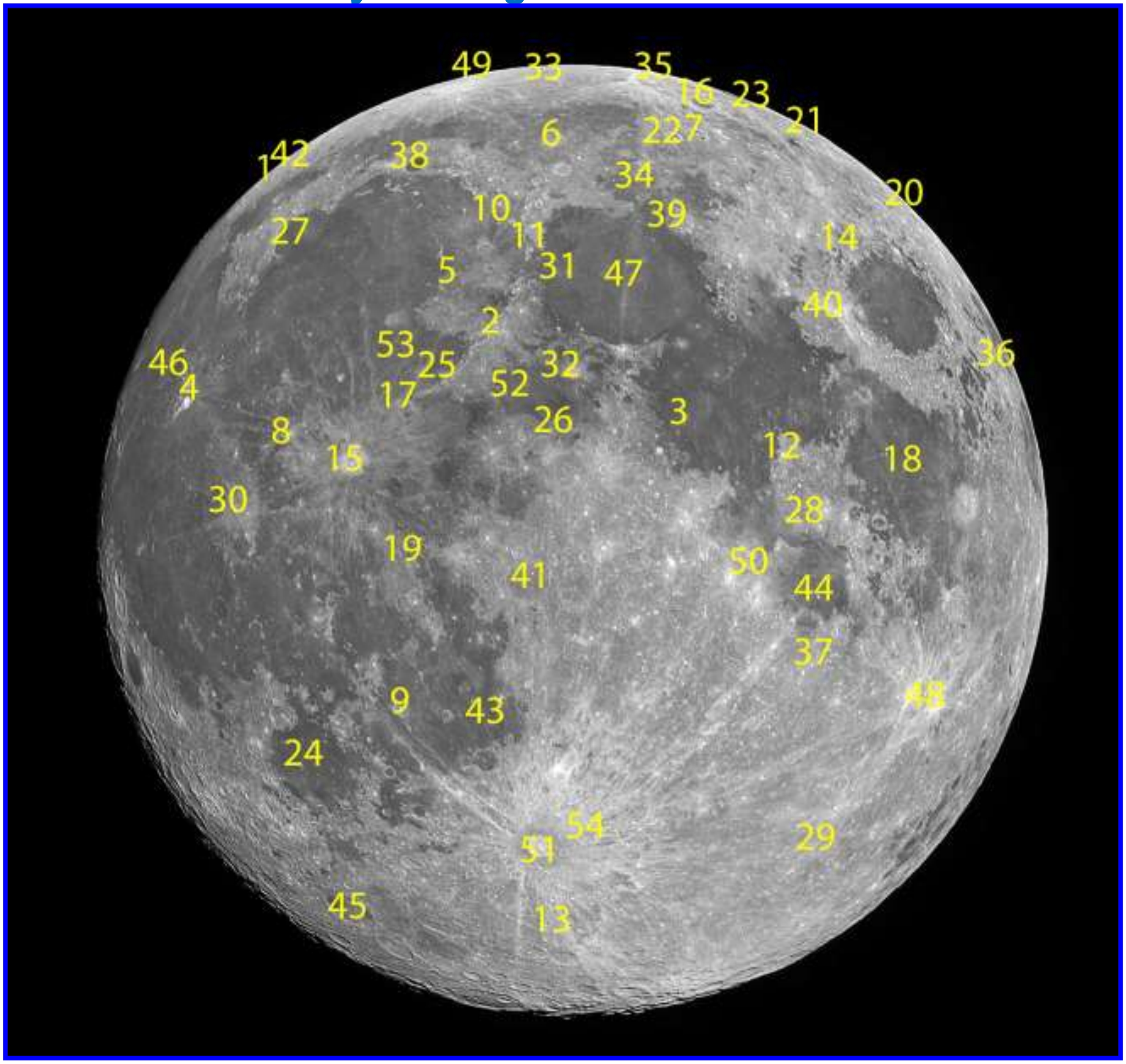
EVER CHANGING ERATOSTHENES

Eratosthenes is a model impact crater, albeit "unfairly" overshadowed by the younger Copernican craters. It is interesting to observe its rim, well defined and with linear segments, its spectacular terraced walls, the central peaks, its irregular and fractured floor full of mounds, and its majestic ramp-shaped ejecta field, formerly known as “glacis”. Eratosthenes is very changeable, it is seen as a deep well of darkness near the terminator, passing through its phase of maximum splendor in the first or last quarter and to practically disappear in full moon, buried by the ejecta of its younger relative, Copernicus. And in addition to Copernicus, Eratosthenes has other very interesting sights: the complex topography of Sinus Aestuum and the grandeur of the Montes Apenninus.

NOVEMBER 2022 ISSUE-**Due October 20th, 2022: ERATOSTHENES**

Fabio Verza

Key to Images In This Issue



1. Anaximander
2. Apenninus, Montes
3. Arago
4. Aristarchus
5. Aristillus
6. Aristoteles
7. Atlas
8. Bessarion
9. Bullialdus
10. Cassini
11. Caucasus, Montes
12. Censorinus
13. Clavius
14. Cleomedes
15. Copernicus
16. Endymion
17. Eratosthenes
18. Fecunditatis, Mare
19. Gambart
20. Gauss
21. Hayn
22. Hercules
23. Humboldtianum, Mare
24. Humorum, Mare
25. Huxley
26. Hyginus
27. Iridium, Sinus
28. Isidorus
29. Janssen
30. Kepler
31. Linné
32. Manilius
33. Meton
34. Mortis, Lacus
35. Nansen
36. Neper
37. Piccolomini
38. Plato
39. Posidonius
40. Proclus
41. Ptolemaeus
42. Pythagoras
43. Recta, Rupes
44. Rosse
45. Schickard
46. Schröteri, Vallis
47. Serenitatis, Mare
48. Stevinus
49. Sylvester
50. Theophilus
51. Tycho
52. Vaporum, Mare
53. Wallace
54. Walter