The Lunar Observer

A Publication of the Lunar Section of ALPO

David Teske, editor
Coordinator, Lunar Topographic Studies Section Program

December 2023

In This Issue

Online readers, click on images for hyperlinks

Lunar Reflections

Wishing each reader and contributor of The Lunar Observer a peaceful and restful Holiday Season, and that it may be shared with loved ones. Maybe some of that holiday cheer will get you out to take a look at the Moon!

It amazes me how much there is to see on the Moon. This month, KC Pau raises a question about "What Are the White Streaks Behind the Western Rim of Copernicus? Later in the issue, Jeff Grainger tours the crater Copernicus, and these "new" features discussed by Pau may be seen, plus later in the Recent Topographic Studies images of Copernicus. Remember that lunar observing began with detailed lunar drawing. Alberto Anunziato discusses this art and science in his article "Seven Notes On Visual Observation and Drawing of the Moon". All very interesting reading. Plus Rik Hill, Paul Walker and Alberto Anunziato contribute interesting topographic tours of the Moon. Plus contributors from across the globe contributed beautiful lunar drawings and images. As always, Tony Cook has a wonderful presentation of Lunar Geologic Change. Many thanks to all who contributed to this issue!

As 2023 ends, check on the ALPO Lunar Gallery > The Lunar Observer for the various indexes of the publication for the past year! Lots of great lunar articles and resources.

Please remember to follow the future Focus-On topics and gather observations of these features. Next up is the very interesting Sinus Iridum. Observations are due to Alberto and myself by December 20, 2023.

Clear skies,
-David Teske

Edited by David Teske: david.teske@alpo-astronomy.org
2162 Enon Road, Louisville, Mississippi, USA
Back issues: http://www.alpo-astronomy.org/

Lunar Topographic Studies

Coordinator – David Teske - david.teske@alpo-astronomy.org
Assistant Coordinator– Alberto Anunziato albertoanunziato@yahoo.com.ar
Assistant Coordinator-Wayne Bailey– wayne.bailey@alpo-astronomy.org
Website: http://www.alpo-astronomy.org/

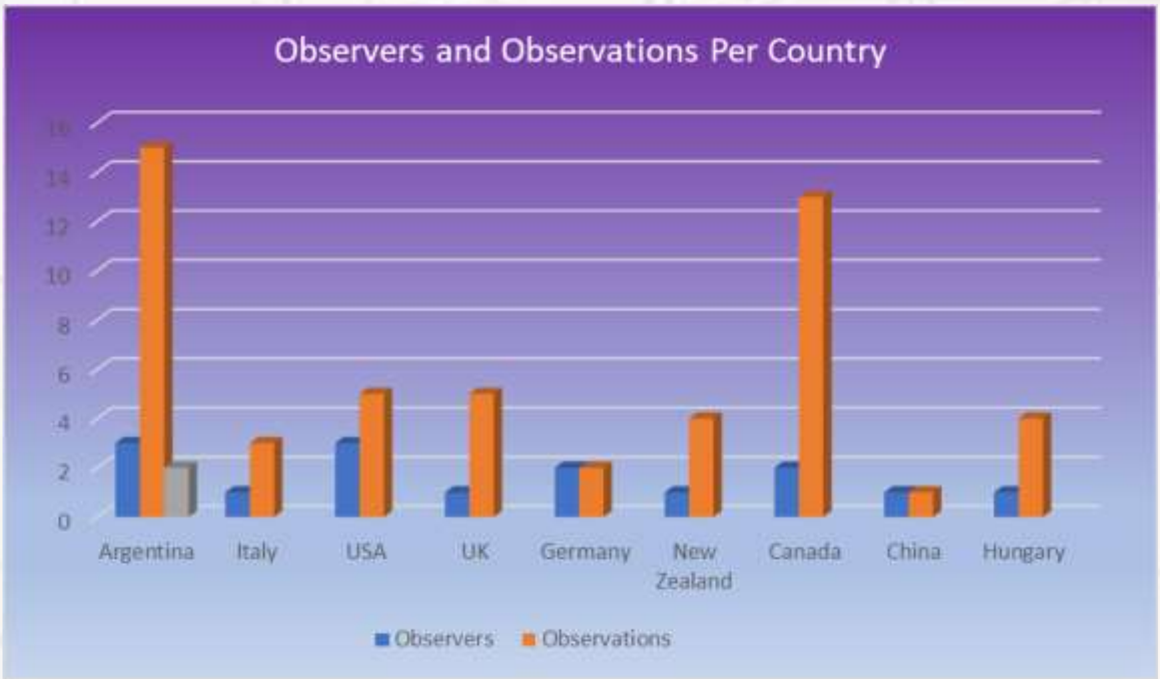
Observations Received

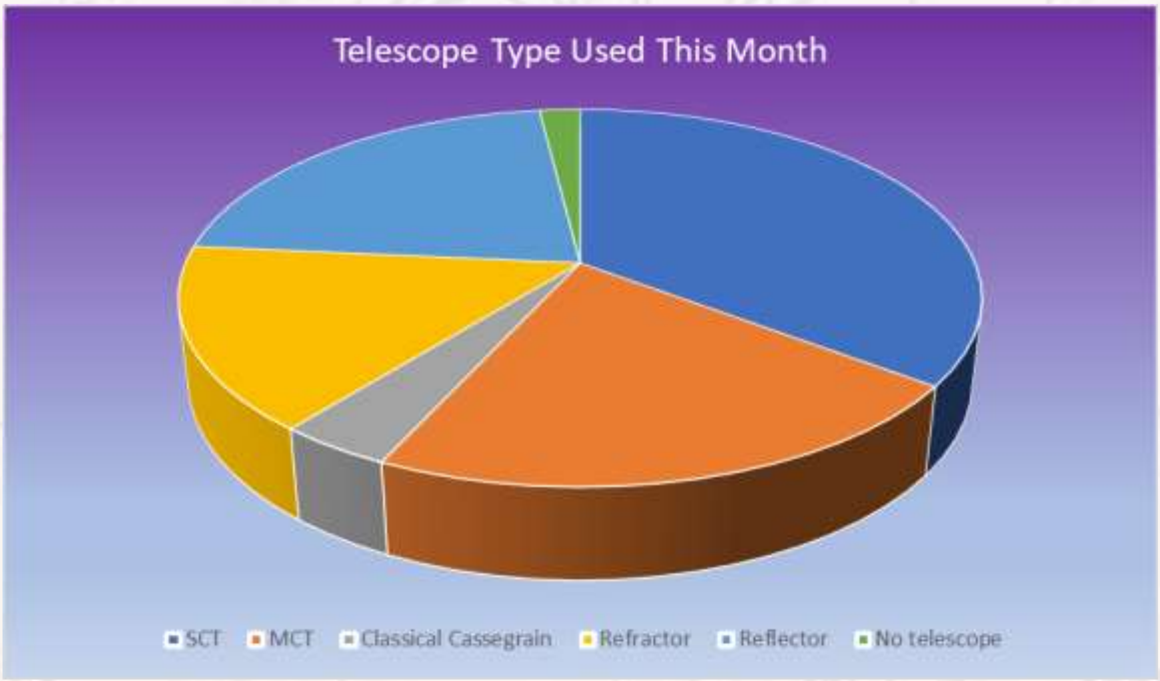
Name	Location and Organization	Image/Article
Alberto Anunziato	Paraná, Argentina	Article and drawing *Dorsum Azara, The Wrinkle Ridge that Runs From Mons Piton to Aristillus* and *Seven Notes on Visual Observation and Drawing of the Moon.*
Matthias Brauchle	Albstadt, Germany	Image of the partial lunar eclipse
Maurice Collins	North Palmerston, New Zealand	Images of Aristarchus, the 13-day old Moon, Bailly and Oceanus Procellarum.
Massimo Dionisi	Sassari, Italy	Images of Copernicus (2) and Reinhold.
Walter Ricardo Elias	Oro Verde, Argentina, AEA	Images of Gassendi (2), Philolaus, Plato and Torricelli.
István Zoltán Földvári	Budapest, Hungary	Drawings of Ramsden, Horrebow, Dorsum Bucher, Montes Harbinger
Jeff Grainger	Cumbria, UK	Article and images *A Tour of Pythagoras and Copernicus Craters.*
Kim Hay	Yarker, Ontario, Canada	Image of the Waxing Gibbous Moon.
Rik Hill	Loudon Observatory, Tucson, Arizona, USA	Article and image *Lacus Mortis and Bürg.*
Fredrick toe Laer	J. Bresser Observatory in Borken, Germany	Image of Kepler to Copernicus
KC Pau	Hong Kong, China	Article *What Are the White Streaks Behind the*
Raúl Roberto Podestá	Formosa, Argentina	Images of the Altai Scarp, Albategnius, Halley, Aristillus and Theophilus.
Michael E. Sweetman	Sky Crest Observatory, Tucson, Arizona, USA	Images of Maginus and the Apennine Mountains.
Kenny Vaughn	Cattle Point, Victoria, British Columbia, Canada	Images of Aristarchus, Gassendi, Gruithuisen, Mare Humorum, Atlas, Cleomedes, de la Rue, Endymion, Langrenus, Mare Crisium, Messala and Petavius.
Paul Walker	Middlebury, Vermont, USA	Article and Image *Mare Marginis, Eastern Mare Crisium and Mare Anguis* and *Mare Smythii, Mare Undarum and Mare Spumans*.

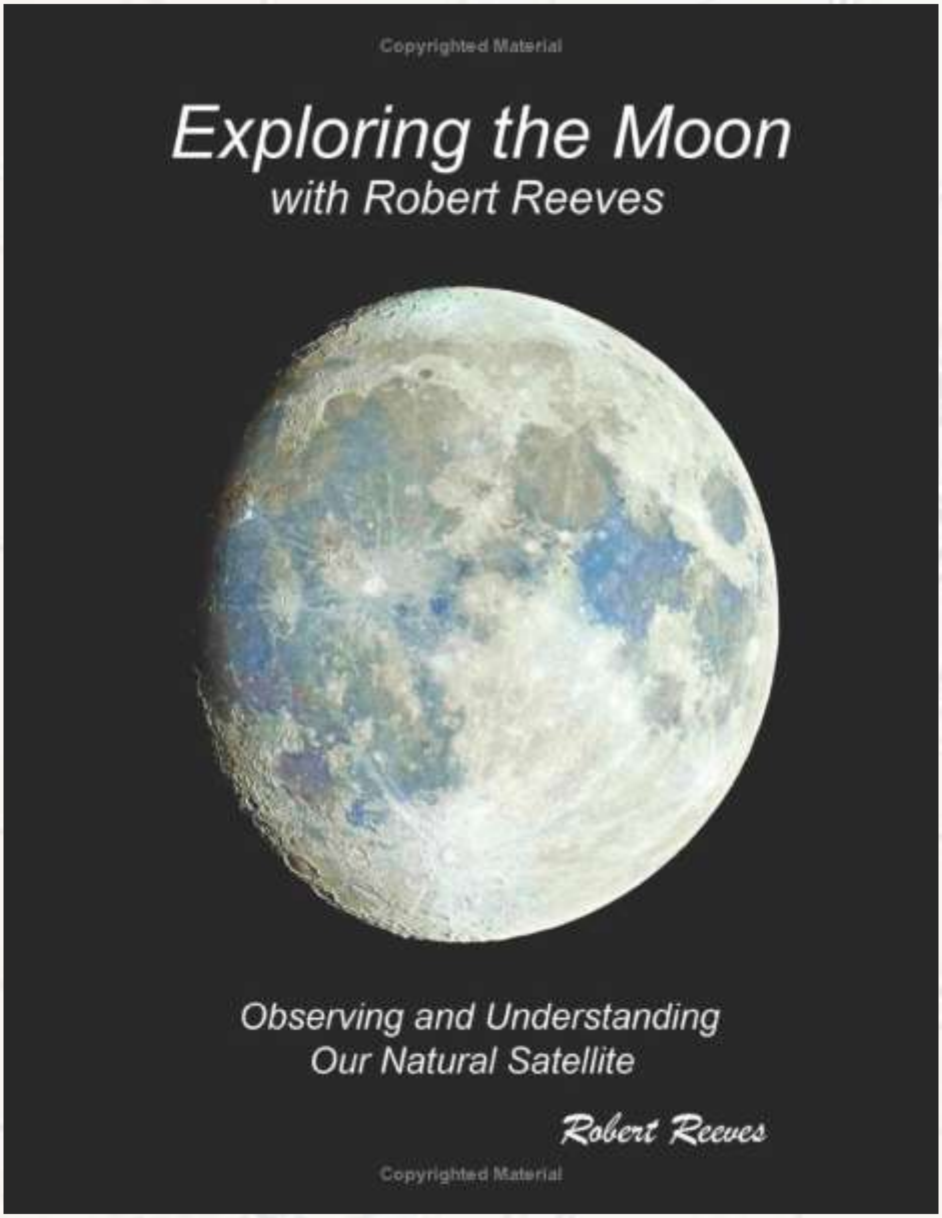
Many thanks for all these observations, images, and drawings.

December 2023 *The Lunar Observer*
By the Numbers

This month there were 52 observations by 15 contributors in 9 countries.







David, the long-anticipated resource by Robert Reeves, titled Exploring the Moon with Robert Reeves has just been released on Amazon.

It is available in Kindle format, soft cover and hard cover.

I bought both Kindle and Hard Cover.

I must say the images and prose are next to none in quality and information.

It's a must have for any of us in ALPO and especially in the Lunar Section.

Can you share this, post it or tell me how I might do so?

Of course, I am not Robert Reeves, nor being paid or otherwise compensated for saying so. I asked this question in last year's ALPO Virtual Conference looking for resources...

Thanks!
John Sillasen ALPO member

Lunar X and V Visibility 2023

Submitted by Greg Shanos

Table 4.3 Lunar X and Lunar V Visibility Timetable

	2023
Jan	29; 00:37
Feb	27; 15:02
Mar	29; 04:59
Apr	27; 18:10
May	27; 06:28
Jun	25; 18:02
Jul	25; 05:07
Aug	23; 16:07
Sep	22; 03:26
Oct	21; 15:27
Nov	20; 04:23
Dec	19; 18:16

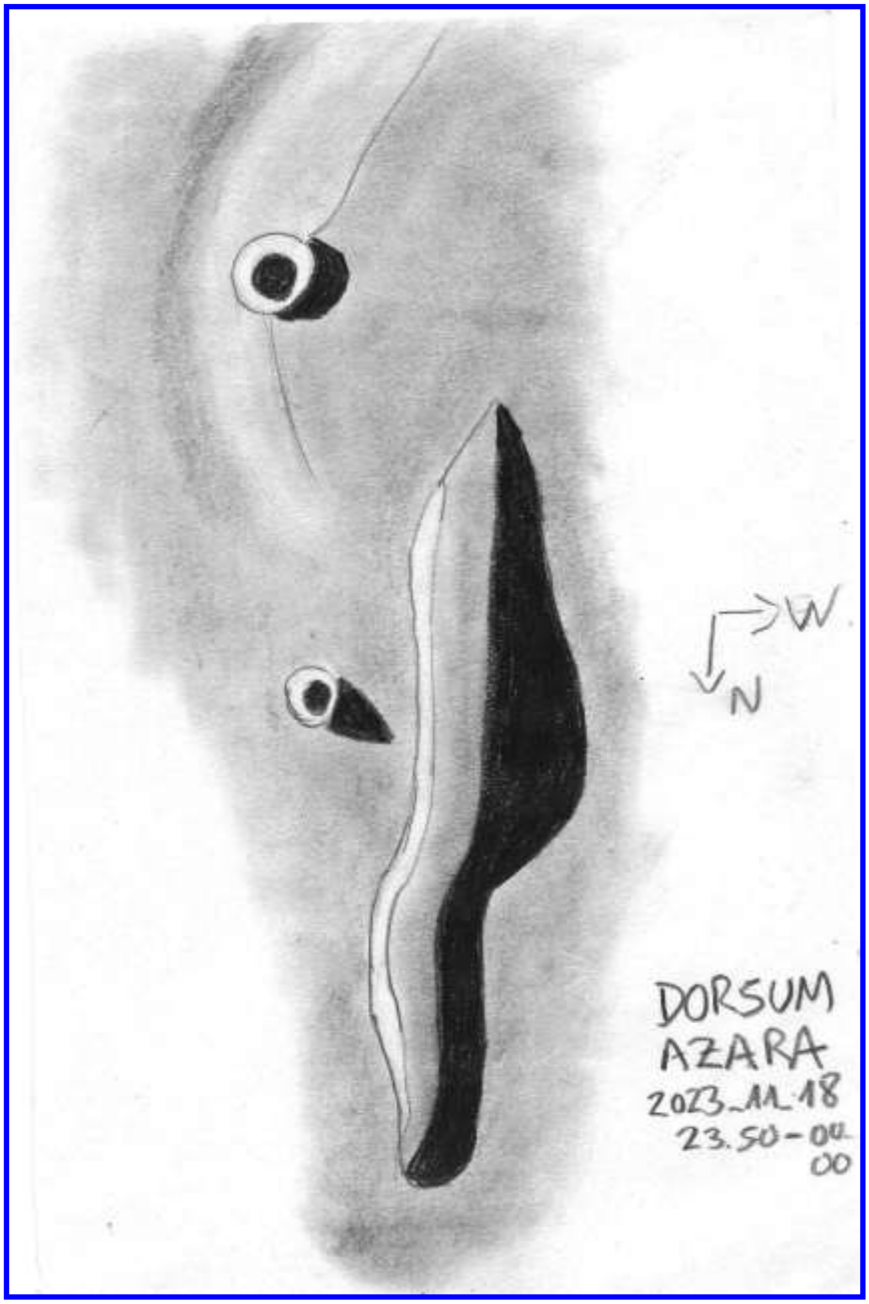
Note: The dates and times listed are based on calculations made with the Lunar Terminator Visualization Tool (LTVT) by Jim Mosher and Henrik Bonda. This useful freeware program may be downloaded from https://github.com/fermigas/ltvt/wiki.

Lunar Topographic Studies

Dorsum Azara

Alberto Anunziato

Dorsum Azara was unlucky to form in Mare Serenitatis west of Dorsa Smirnov, the most prominent wrinkle ridge of all. To locate ourselves in Mare Serenitatis, the craters we see (both with the typical bowl shape of small craters, which is visually perceived as a bright ring composed of its walls and a perfectly round interior and completely covered by shadows) are Bessel D, the small crater, 5 km in diameter, to the north; and Sarabhai to the south (8 kms in diameter). Looking at maps after the drawing (I should have done it before) I see that Sarabhai should be much further away from Bessel D. The best description belongs to Robert Garfinkle in Luna Cognita: “Running generally north to south is the twisting ridge of Dorsum Azara. This low narrow ridge rises south of the bright cone crater Bessel D, turns south at Sarabhai, and ends at the crater Deseilligny. Most of this ridge is less than about 200 meters (656.16 feet) in elevation. This ridge is best viewed in very low angles of solar illumination.” It is interesting how different Dorsum Azara are from the segment that runs further south (which I believe does not belong to Dorsum Azara), which does not cast a shadow, which is hardly distinguishable from the surrounding mare surface, the eastern slope is practically indistinguishable, more than a slight difference in tone. Dorsum Azara presents the common structure in a dorsum, the gently sloping arch and the crest, the upper structure, irregular and steep, on one of the margins (in this case the eastern slope). What seems less characteristic is the western slope, which also seems quite high. The prototypical structure of the arch is one steep slope and the other gentle. In principle, the eastern slope would be the steep slope, where the crest passes, and the gentle slope would be the western slope (according to what I have seen in the atlases), but the pronounced shadows seen to the west would not be so indicative of a gentle slope. And Garfinkle also tells us that Dorsum Azara is not very high. The shadows to the west seem a bit anomalous, perhaps I recorded them incorrectly and they weren't actually extensive.



Dorsum Azara, *Alberto Anunziato, Paraná, Argentina. 2023 November 18 23:50-00:00 UT. Meade 105 Maksutov-Cassegrain telescope, 154x.*

Lunar Topographic Studies
Dorsum Azara

Mare Marginis, Eastern Mare Crisium, Mare Anguis, from Seneca to Neper

Paul Walker

I lucked out with a Longitude Libration of +4 deg. 49' and Latitude Libration of –1 deg. 6' (a little south of Smythii). Not the best, but good enough to get a good view of Mare Marginis. Seneca crater at top of the image, left of center is not very obvious, Plutarch just below it is more defined and has a small central peak. To the lower left of Plutarch is Hubble with just tiny bit of its central peak visible. There are features showing beyond Hubble but with the extreme foreshortening I can't identify them even when viewing the Moon in "Full Disk" mode in the Virtual Moon Atlas (VMA).

A small sea, Mare Anguis, is just off the northeast edge of Mare Crisium. I thought it odd that Mare Anguis is labeled as a sea rather than a bay. But when I looked up the translation "Sea Serpent" it makes sense, as it looks kind of like its name. In addition, it does not appear to have a direct connection to the lava flows that filled Crisium.

Viewing the area in the VMA in "Full Disk" mode it appears that almost all of Mare Marginis is visible here. The near and far walls of Goddard, located on the northeast edge of Marginis, are prominent. Beyond the south end of Goddard, what appears to be the top of the far wall of Ibn Yunus is still catching the last rays of sunlight. They are about 2/3 and 3/4 the way across Mare Marginis respectively. I noted on the VMA, a feature labeled as a crater, Hanson B, on the West Side of Mare Marginis. Hanson B is definitely a lava filled depression. Perhaps with the difficulty of getting good views of it, it was assumed to be a crater. VMA info says it is 80 x 80 km. Measuring the basin with LROC QuickMap it comes out to about 40 x 70 km so I don't know where the stated size comes from. It would seem this is not a true crater, but I could be missing something. Just west of Hanson B is another lava filled depression. This one is long and skinny. The odd thing here is that I don't see any name attached to it. It is farther from Mare Marginis than Hanson B so would seem it would not be considered part of the mare. It is also completely detracted from Marginis.

To the south of Mare Marginis is the large crater, Neper, with a nice central peak and 17 km Virchow inside its north end. The crater just behind Neper is Jansky. In the bottom center of the image is the North end of Mare Undarum.

Lunar Topographic Studies
Mare Marginis, Eastern Mare Crisium and Mare Anguis

What Are the White Streaks Behind the Western Rim of Copernicus?

KC Pau

On 23 October 2023 evening, the sky became clear after a long period of cloudy days. The gibbous moon was just in between the two high rise buildings opposite to my balcony. Within the telescope field of view, I found the morning terminator was very close to the west rim of Copernicus. Southern part of the west rim first appeared as a few short bright streaks under the early morning sunlight. Later on, northern part of the rim began appearing as another several bright streaks. Two parallel very short bright streaks were also visible just west of the northern part of the rim. Now the whole arc of the west rim was almost completely visible. The two bright streaks were still there (fig. 1). Certainly, they were real features, not an illusion. What are they? Are they part of the west rim? Questions filled up my mind. To my understanding, these two streaks should have the same height as the west rim. Otherwise, they would not be lit up by the sunlight simultaneously as the west rim. As far as I know, there seems to be no geological features which are as high as Copernicus in the vicinity. Then I checked another Copernicus photo taken on the next evening (24 October) to see if there is any peculiar feature along the western crater flank. Two prominent bumps were found at the corresponding position of the bright streaks and were not far away from the west rim (fig. 2). The next step, I used the path tool of the QuickMap to produce the cross-sectional view along the said crater flank. The outcome was quite surprising as the height of the two bumps was higher than the west rim (fig. 3). The high-resolution photo of the QuickMap shows these two bumps to be two long and rather flat-top ridges, running parallel to each other in north-south direction (fig. 4). They may be the thick ejecta that had deposited along the flank during the formation of Copernicus. Cross-sectional views of these two ridges along the N-S direction reveal that both the highest part is at the southern end (fig. 5, 6). Thus, this portion of the ridges would receive the morning sunlight earlier than the other part and appeared as two short bright streaks.

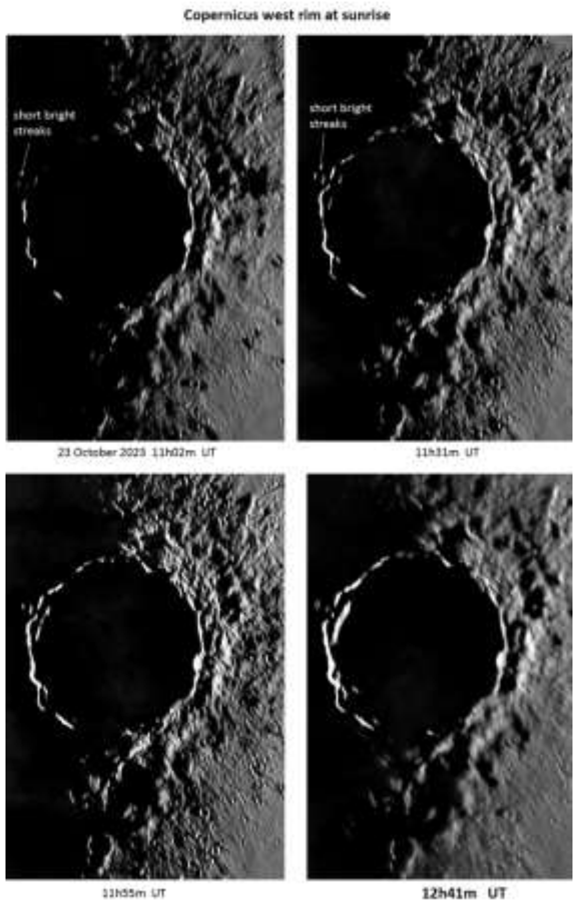


Figure 1

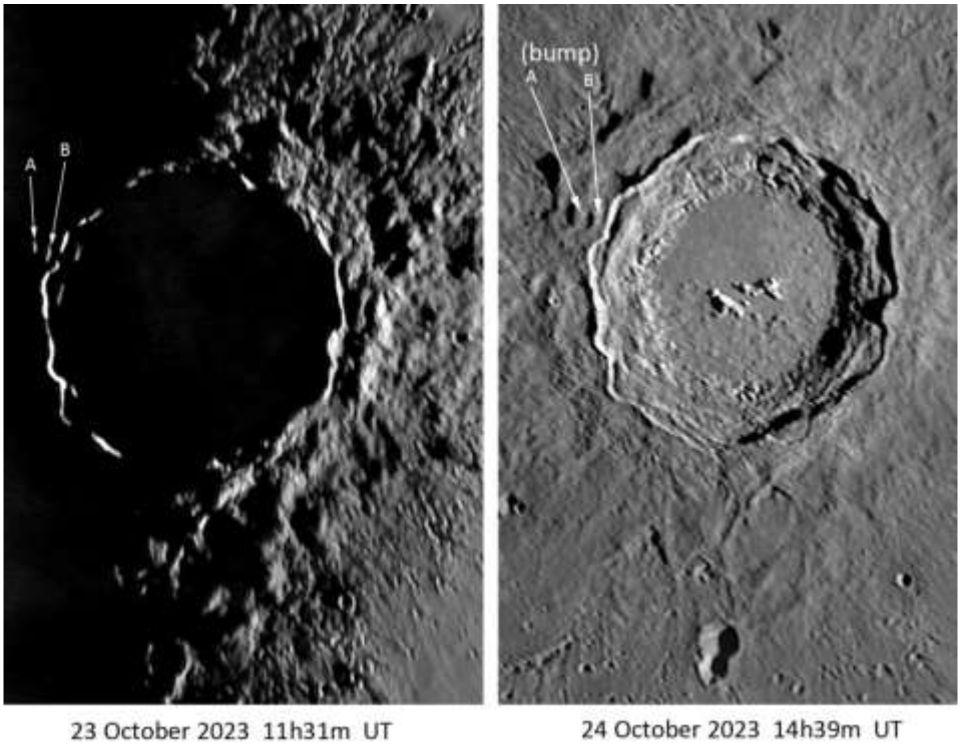


Fig. 2

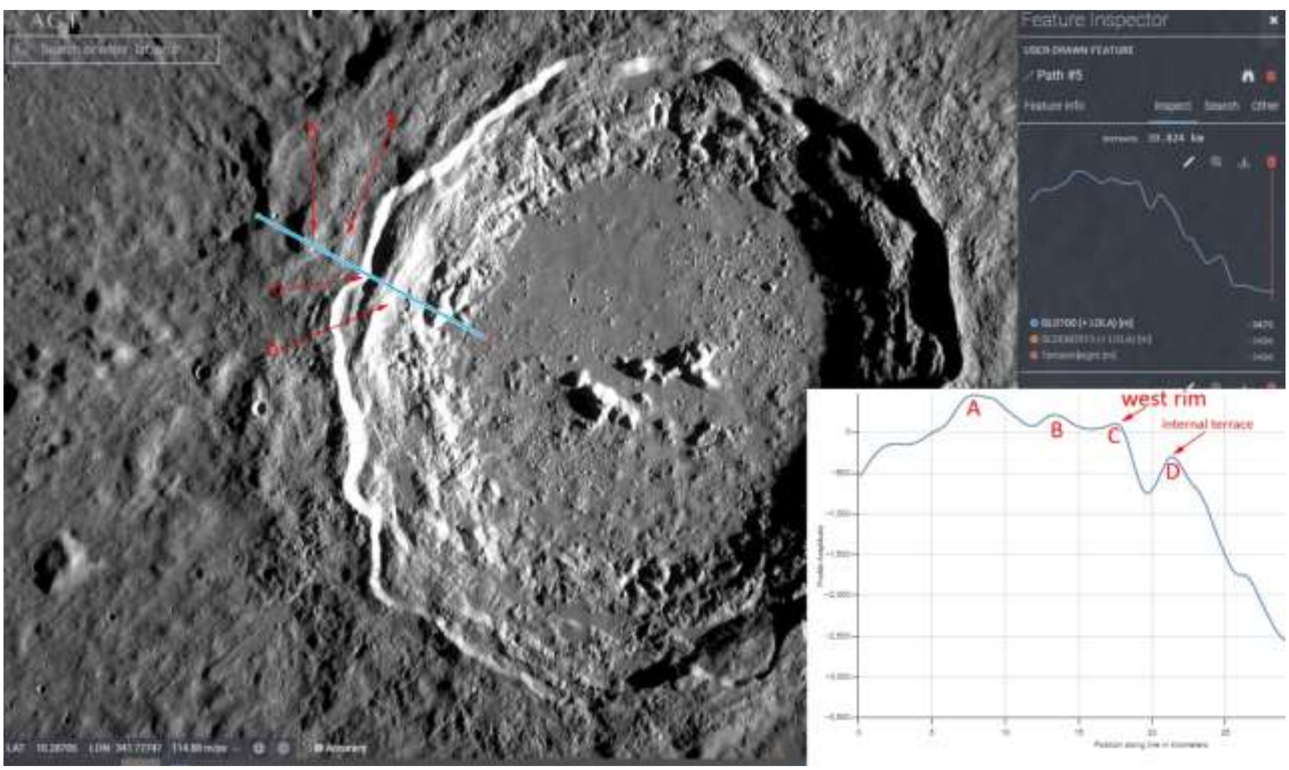


Fig. 3

Lunar Topographic Studies
What are the White Streaks Behind the Western Rim of Copernicus?

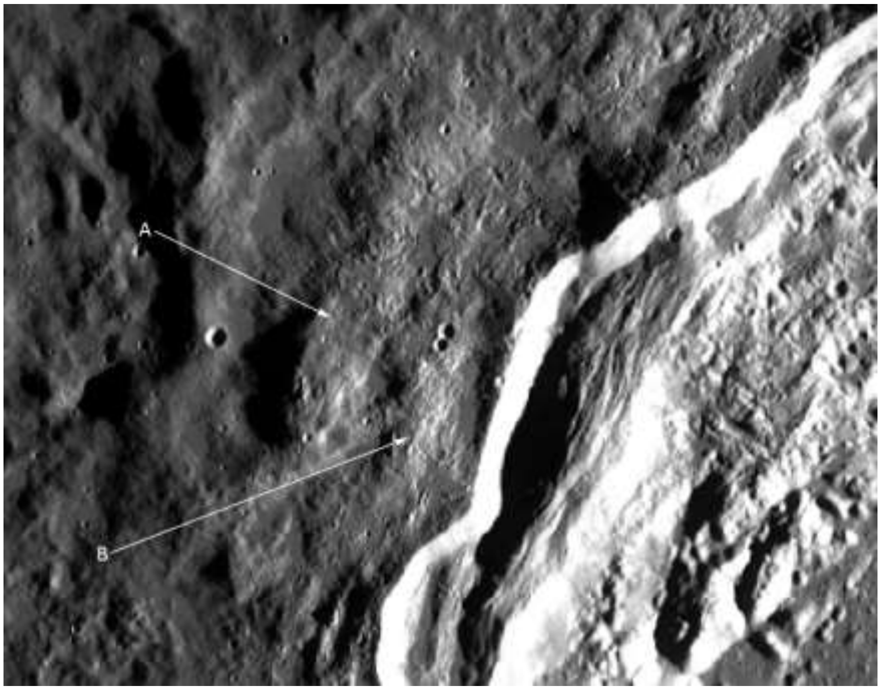


Fig. 4

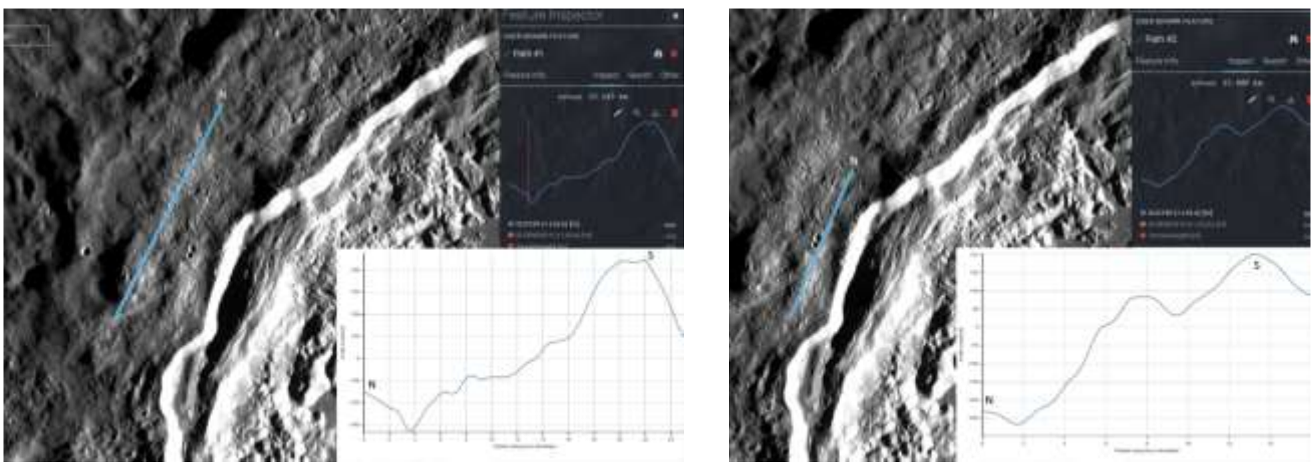


Fig. 5, 6

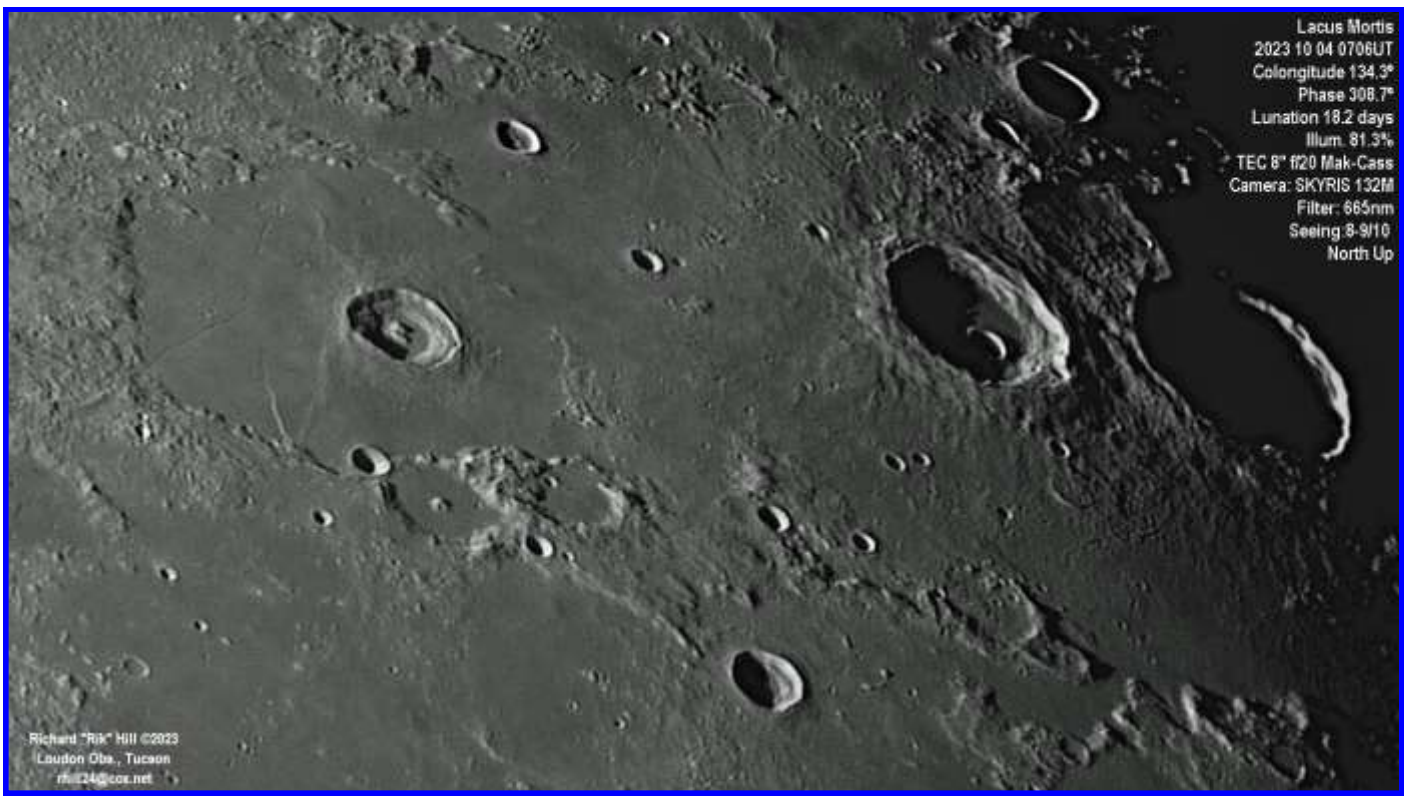
Lacus Mortis and Bürg

Rik Hill

The region of Lacus Mortis (left of center) is the hexagonal plain with the nearly central crater Bürg (41 km dia.) that has a valley dividing its central peak in two, surrounded by nice hummocky terrain for another 40 km or so. There are some interesting rimae (what we used to call "rilles") around the Lacus starting at the 8 o'clock position from Bürg where there is a shear fault that points to the north from the rim of the Lacus. Moving up from there is a graben that extends out to the north of Bürg. Then above Bürg is a short rima only about 25-30 km long, that appears to be a catena formed from impact debris, probably from the Bürg impact since it is the youngest in the area, being of Copernican age (1.1 billion years ago to present).

Below Bürg are a pair of craters, the flat floored or flooded crater Plana (42 km) and to the right of it is a smaller flat floored crater, Mason. Between them and below (south) is the crater Mason B, a very fresh crater as is the small unnamed 3 km crater below and to the right of it. About 20-25 km below Mason B on the plain of Lacus Somniorum, is a low isolated dome. Moving further south you come to the crater Grove (29 km) at the bottom of this image. Due east of Bürg (right) are the two large craters. The nearest being Hercules (68 km) with the large Hercules G (13 km) crater on its floor. Then deep in evening shadow further east is Atlas. These two craters are more familiar to the amateur observer as two of the more identifiable features in the waxing crescent moon.

Notice above Atlas there is the hint of a crater outline. This is Atlas E (59 km), very ancient possibly pre-Imbrium, and deeply overlain by ejecta from both Atlas and Hercules. Further north you can just make out Keldysh (33 km) almost completely in the night's shadow.



Lacus Mortis, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2023 October 04 07:06 UT, colongitude 134.3°. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 665 nm filter, Skyris 132M camera. Seeing 8-9/10.*

Lunar Topographic Studies
Lacus Mortis and Bürg

The Wrinkle Ridge that Runs from Mons Piton to Aristillus

Alberto Anunziato

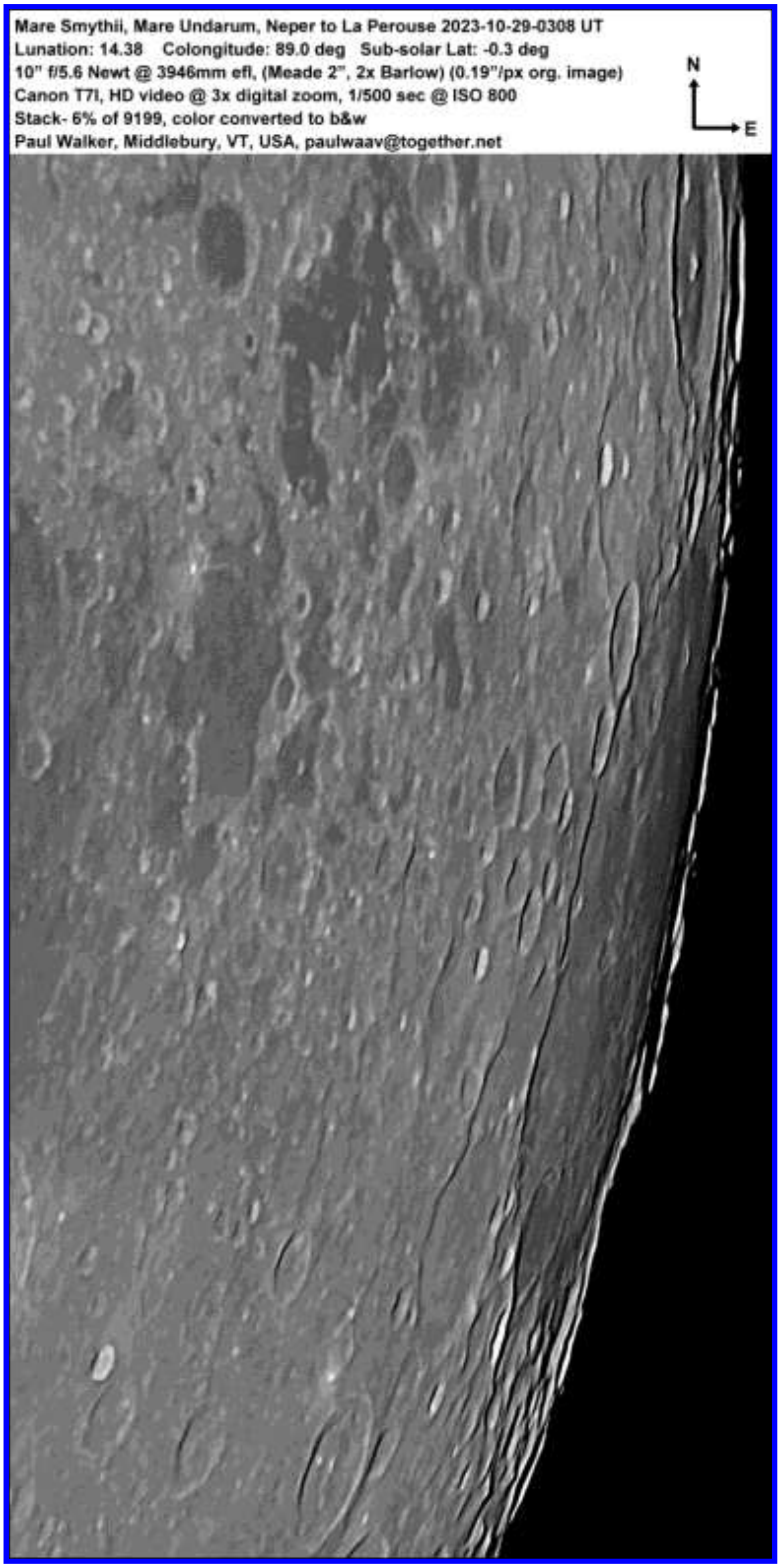
What we see in the image is a low wrinkle ridge with a simple topographic structure. It runs from Mons Piton, at the northern end of the image, shining brightly, to the Aristillus ejecta blanket, which was in shadow at the time of observation. We say that it is not very high because despite the favorable lighting conditions, very close to the terminator, a complex structure was not noticeable and its shadow was not so pronounced. Visually, small ridges look much more sinuous than they really are. With a small telescope like mine this wrinkle ridges seems to change direction in a wavy manner, from lunar orbit surely these changes of direction are much straighter. Nor could it be stated that what we see as a single arch is really just one and not that our vision, due to lack of resolution, is uniting two or more segments. We also do not see the upper part of the model wrinkle ridge, the crest, it may be because we cannot see it or it is really missing, as in the smaller ridges. The part of the segment closest to Mons Piton was the most interesting to observe, especially the shape of the shadow, which would denote a more complex structure, while in the part of the segment in which it changes direction towards the west the most noticeable higher part, with longer shadows. The most prominent part of the shadow, near the northern end, probably corresponds in part to the shadow of the Piton B craterlet (5 km in diameter), obscured by the shadow of the dorsum. The craterlet seen on the right is Piton A (6 km in diameter). And the bright elevation seen to the west is a probable outcrop of one of the rings of the Imbrium basin, like Mons Piton itself.

Dorsum From Mons Piton to Aristillus, *Alberto Anunziato, Paraná, Argentina. 2023 October 20-21 23:52-00:03 UT. Meade 105 Maksutov-Cassegrain telescope, 154x.*

Lunar Topographic Studies
The Wrinkle Ridge That Runs From Mons Piton to Aristillus

Mare Smythii, Mare Undarum, Mare Spumans, from Neper to La Perouse (N-S) 2023-10-29 03:8 UT

Paul Walker



The main features are Mare Smythii at far right, center. Smythii requires favorable libration. Mare Undarum is top center and extends down about 1/4 of the image. To its lower left is Mare Spumans, which extends from about 1/4 to 1/2 way from the top of the image. Just to Spumans' left is the edge of Mare Fecunditatis.

According to LROC QuickMap, Mare Undarum is just inside the outer ring of Mare Crisium (out of view to the north). Mare Spumans is on the outer ring. Throughout this area there are lava-flooded craters making the overall area of Undarum and Spumans appear bigger. The largest of these craters is 56 km Firmicus. Almost touching Firmicus' northwest edge is the small lake, Lacus Perseverantiae Going to the top, upper right, we have the large crater, Neper. You may have noticed this crater is at the bottom of my other image. Again, it has a nice central peak and 17 km Virchow in its north end. The crater just behind Neper is Jansky.

Several craters can be seen within Mare Smythii however, few were noticed visually. The overlapping craters Kiess (55 km) and Widmanstätten (46 km) at the south end of Smythii, visually, showed as a dark patch. I did not notice the walls of the craters so I had assumed this was just a darker patch on the mare floor. There are other craters on the floor of Smythii in the image that were likely visible as well but I did not take note of them.

The southern most fair-sized crater in the image is 78 km La Perouse. It has a central peak as well as a small mount between that and the near wall.

Seven Notes on Visual Observation and Drawing of the Moon

Alberto Anunziato

I would like to share some reflections on the practice of visual observation, an art, or in more pedestrian terms, a technique that has certainly ceased to be essential with the advent of CCD technology for image capture. Photographic observation with this type of camera is clearly superior by allowing, first of all, the obtaining of objective data, while in visual observation the data depend (unfortunately) on the capacity of the observer (a factor that will always be predominantly subjective). But visual observation allows for some reflections on how the visual perception of a world similar to and different from our own is constructed, mediated by the instrument we use. Do we record what we see objectively? One would think so, but it is also true that selenographic formations as evident as the dorsa were only recently recorded after almost two centuries of telescopic observation, which brings us to the first note.

1.-KNOW WHAT WE SEE.

Following the incredible "A Treatise on Moon Maps" by Francis J. Manasek, we see that the visual observation, reflected in the maps that were made, was determined by the objective that prevailed at the time of making it. While the objective was to map the entire near side as accurately as possible, the details of each selenographic accident were not recorded (or were they not perceived?). It is with Von Schröeter's "Selenographic Fragments" that what Manasek calls "chorography approach", the detailed mapping of small areas, begins to prevail. Unrecorded characteristics of lunar features begin to be mapped: rims and central peaks of craters, also wrinkle ridges and rilles. Before Von Schröeter, these details were not observed or simply not recorded? Were they not recorded because they were considered useless for the purpose of the great general maps? Or were they not recorded because a semiotics, a taxonomy to guide observation had not been discovered? In Manasek's terms: "The present study detected evolutionary changes in the way craters were depicted (…) Perhaps this evolution suggests a required lengthy period of learning to perceive and interpret optical images, starting with the initial ambiguity following Galileo and not really coming to fruition until the 19th century, or that the codification of such detail required the more intensive observations resulting from chorographic presentation of lunar surface detail. We might argue that the central peak achieved recognition as selenology and geologic science developed".

Knowing what we are going to see, at least the general characteristics, allows us to focus the observation on the most important aspects, or at least the aspects that based on said knowledge we can consider most relevant, and here selectivity comes into play, which leads us to the second note.

2.-THE IMPORTANCE OF REGISTRATION

We have sometimes compared in this magazine the visual and photographic observation of the same selenographic feature, the dorsum that terminates in Herodotus A, is an example, under similar illumination conditions (near the terminator). The text is called "Morphological components of wrinkle ridges detected in digital images" and is in the April 2021 issue of The Lunar Observer. To be brief, the conclusion we could draw from this comparison could be that sight is more astute than photography and photography is more precise. We will return to this idea.

Lunar Topographic Studies
Seven Notes on Visual Observation and Drawing of the Moon

All visual observers know the distressing feeling that we do not register with the hand that draws all the details that we see with our eye through the eyepiece. One of the first selenographers and the author of the first lunar encyclopedia, “Selenographia”, Johannes Hevelius, dwells on this problem, aggravated by how tiring it was to observe without tracking. Hevelius considered the possibility of working with a draftsman, but the problems were greater than the advantage of having someone who knew how to draw, since the draftsman would be drowsy during night observation or directly asleep (and would not go to the observatory) or he would not know what was important to record and what was not. Hevelius already realized in 1647 that we necessarily select the information at the time of observation, as Manasek says when talking about lunar maps before 1910: “The veracity of a printed image derived from visual observation does not necessarily represent the totality of the observer's vision. Rather, it possibly has been selectively modified toward “reducing information to manageable dimensions.” (…) The hermeneutic view that perception is not primarily theoretical but that objects declare themselves (cf. Rouse) perhaps is most valid if we are in a world of already existing relevant meaning, and images have names, are intellectually and culturally coherent, subject to categorization and analysis. The image may be self-declaring but we may not understand the declaration", when the special exploration has added an impressive amount of information about the Moon, we are no longer in the same conditions as the classic selenographs that we admire so much, now the image is more evident and, above all, we can confirm, to a large extent, our visual perception (we will return to this).

If visual observation even today preserves the observational biases of the golden age of selenography: subjectivity in the interpretation of what is seen through the telescope, variation in the degree of visual acuity of the observer, degree of prior knowledge that determines the selection of the objective, the selection is primordial because the features that are considered essential are recorded, not all of them, that is why it is essential to be clear about what to record and how our observation selects information that could add something new. In photographic observation, the volume of information accessed by the observer at the moment of observation is less than that which the subsequent user (the observer himself included) can access, for example by enlarging the image or playing with contrast. Visual observation, on the other hand, is closed: the observer has more information at the time of observation than what is finally recorded on paper, what is not recorded is lost, which is why it has always been important how to deal with the selection of the information that the observer considers valuable and worth recording, which brings us back to Hevelius's concern for the hand that draws. Among the frequent contributors to “The Lunar Observer” are many excellent lunar observers which are fine artists, whose drawings speak for themselves. Those of us who do not have such a good hand must improve the drawing with the addition of a lot of information in the form of a report that is as complete as possible.

We return to the dichotomy between the acuity of visual observation versus the precision of photography. The golden age of lunar cartography based on visual observation and drawing and subsequent printing was guided, until well into the 19th century, by the ambition for precision in the location of selenographic features. Today that precision is available to anyone using, for example, the online Lunar Reconnaissance Orbiter Quickmap. The cartographic precision of our observations is no longer so important, as they can be corrected a posteriori. I believe that visual observation should focus on the changing appearance of the lunar surface as the illumination changes, especially taking advantage of the possibilities offered by the terminator zone: “One of the ironies of lunar observing is that a homemade 6-inch reflector is capable of revealing much of the detail that can be photographed through the largest telescopes on Earth…. Your brain can discard the periods of fuzzy seeing and concentrate on the fleeting moments of sharp viewing”, which applies especially to maria: “the surfaces of lunar maria are typically so flat that you have to look closely to see any relief. But because the Moon lacks any significant atmosphere to dim and diffuse the Sun’s rays, every small crater rim and hillock cast a long black shadow when the Sun is low. This “shadow magnification” permits viewing many fine details that provide information unavailable from studies of mare surfaces under higher illumination… with “shadow magnification” you can see vertical features only 25 to 50 meters high, because they cast shadows thousands of meters long! Cruise the terminator with high magnification, and if the seeing is steady, you will be rewarded with details unknown to scientists who study only Lunar Orbiter photographs that are compromised by their relatively higher Sun angles (Charles Wood in The Modern Moon). Specifically, observing close to the terminator makes it possible to take advantage of the conditions conducive to recording the intensity of bright areas (as indicators of high areas, for example), the extent and gradation of shadows, etc. It is interesting to reflect on the geometry and tones of what we observe through the telescope on the lunar surface. John Willats in his essay “The draughtsman’s contract. How an artist creates an image” makes an interesting reflection on how the brain interprets visual data, in the form of light intensity, which I think is important for our topic (I cannot make a verbatim quote because I do not have the original book but the version in Spanish, which I adapt in English): Images can be described in another way, according to the variable relationship between the different marks on the surface of the images and the real-world elements that they denote. The marks represented in images such as photographs (lights and shadows when incident on the film) denote points of intersection of tiny beams of light as captured by the camera or as the camera would have captured them or the retina of the viewer in its place. The brain has to interpret the variations in light intensity that the image presents to extract information from it, in the same way as when it interprets the arrangement of light in a real scene by impressing the retina. In images of this type-impressionist and pointillist photographs and paintings-the artist and the operator remain passive when it comes to the representation of the form and the task of interpretation falls to the viewer. In architectural drawings and in most children's drawings, the artist is in charge of extracting the elements, which he then represents directly in the illustration.

Through the eyepiece, our retina captures defined lines (the outline of a crater or the extent of a rille, for example) and lights and shadows (with gradations). Defined lines do not need interpretation, they need precision in their drawing. It is also true that the precision that was required in visual observations prior to the images captured in lunar orbit is not so necessary, because we can replace it with the immense wealth of publicly available data, for example, in the Lunar Reconnaissance Orbiter QuickMap. The variations in light intensity, brightness and shadows do require interpretation, because they denote information (the outline of a shadow denotes the shape of a cliff that we cannot see, for example); which brings us to the next three notes.

3.-THE RECORD OF SHADOWS

Reflecting on how shadow gradations are observed on the Moon, I find it useful to make a distinction between craters and elevations. I reviewed my drawings in my observation notebooks, but it seemed more precise to me to remember how the shadows are really observed. The subsequent record is always more schematic, which is why it is important to use the Elger albedo scale at the time of observation. My indolent spirit has prevented me from observing the full moon to learn this scale, but trying to remember gradations of dark areas and brightness has strengthened my will to do so, since I begin to imagine scales, which would be very imprecise compared to the scale by Elger. But, for now, it seems to me that inside the craters there are usually at least two types of shadows, the very dark ones (the most common, which are also the walls) and the lighter ones, which can also be divided into the lighter shadows. clear ones that indicate the advance of light on the irregular surface, as in the Schickard crater, or shadows just a little less dark than the neighboring shadows, as can be seen in the inner shadow of Tycho (as seen in IMAGE 1, in which different tones are marked with 1 and 2 in tha shadow zone), or of Ptolemaeus, for example. In the case of elevations, the cause of the differences is clearer, darker shadows indicate steeper relief and, in that case, I have not been able to observe more than 3 shades of shadows projected from a wrinkle ridge or by the exterior walls of the craters in flat areas like the maria (as seen in Image 2).

Image 1, Tycho, *Alberto Anunziato, Paraná, Argentina. 2023 May 28 22:50-23:10 UT. Meade 105 Maksutov-Cassegrain telescope, 154x.*

Image 2, Piazzi Smyth, *Alberto Anunziato, Paraná, Argentina. 2022 September 04 00:00-00:20 UT. Meade 105 Maksutov-Cassegrain telescope, 154x.*

Lunar Topographic Studies

Seven Notes on Visual Observation and Drawing of the Moon

4.-THE REGISTRATION OF BRIGHTNESS

The gradation of bright areas is more difficult to measure and much more subtle in its variations. Clearly the brightest areas are the areas of most recently exposed material, with frontal illumination, as indicated by the Elger scale, from Bullialdus (5.0), through Copernicus (8.0) to the central peak of Aristarchus (10). But in addition to denoting recent material, the bright areas indicate height when they are close to the terminator, in which case there would seem to be a gradation of at least 3 shadow tones, which are usually seen on the wrinkle ridges, indicating different heights.

5.-HOW WE PERCEIVE DEEP TERRAIN

A special case, a variation on how the shadow near the terminator denotes altitude, is a certain very slight shade of shadow, lighter than the shadow tones that indicate height, which also extends into an area where there are no heights. That intuitive look that tells us that there may be a slope can be verified with the altitude data from the LRO Quickmap, for example (as we see in IMAGES 3 and 4).

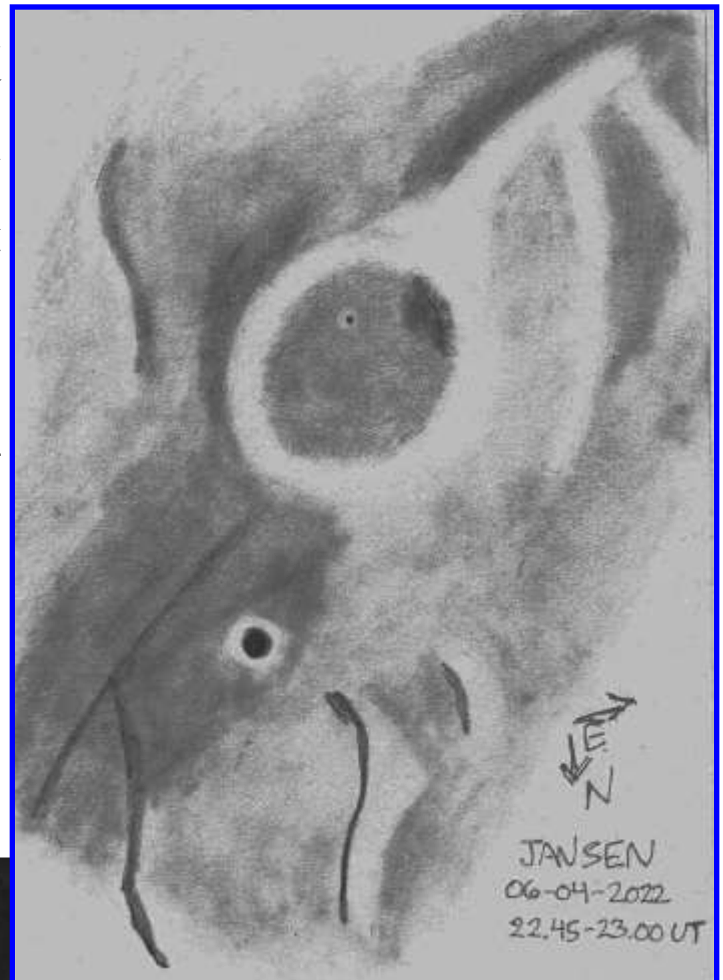


Image 3, Jansen, *Alberto Anunziato, Paraná, Argentina. 2022 June 04 22:45-23:00 UT. Meade 105 Maksutov-Cassegrain telescope, 154x.*

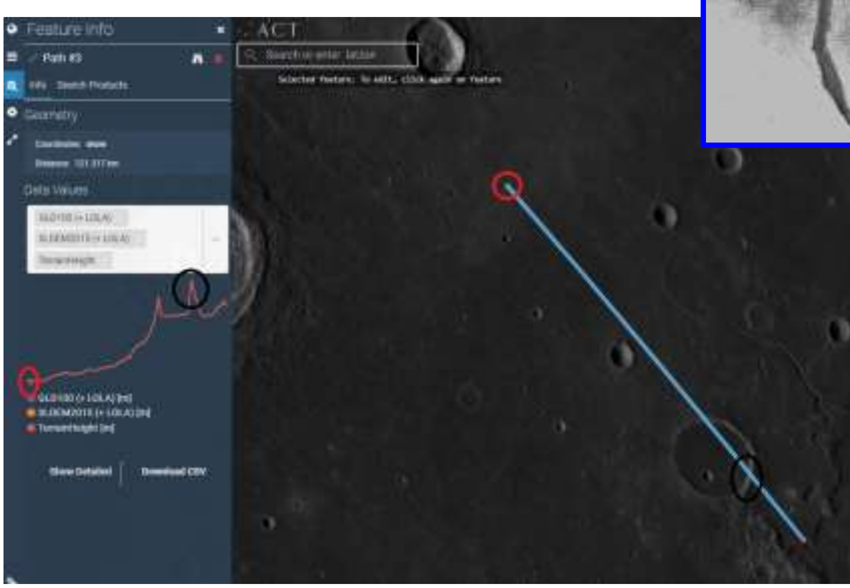


Image 4, Jansen, *LROC*

6.-THE ESSENTIAL CONFIRMATION

In spirit of controversy, we can affirm that the heroic age of visual observation of the Moon (magnificently narrated in that masterpiece that is “Epic Moon”) provided us with most of the scientific data that we know today about the Moon, which is achieved despite the subjective element inherent in visual observation. And great examples are the classic errors that have garnered so much ridicule, such as the appearances and disappearances of the Linne crater or the infamous O'Neill’s Bridge. But those errors should not hide how valuable visual observation was… is it valuable still? I think visual observation can still be valuable if it depends on the photographic image. During a good part of the 20th century, visual observation refined the details, taking advantage of the cartographic precision of photography. Examples of visual observation using photographic images are the magnificent work of Johann Krieger and the United States Air Force lunar mapping for Apollo Project, prior to the Lunar Orbiter missions, which started from photography and ended visually. Today we know the surface of the Moon with an enormous degree of detail, our observations are almost unnecessary, but observations from Earth with oblique illumination can still improve images in orbit with frontal illumination (such as the study of domes). A new paradigm for visual observation could be based on the selectivity of the visual observer and the possibility of the photographic confirmation. Without photographic confirmation, visual observation is not valid today.

In this way we continue the approach of classical selenography: each observation adds a detail to the complete panorama of a particular region of increasingly reduced size. So, we have a visual observation with a previous theoretical framework that provides perhaps the last thing visual can give: selecting an anomalous detail that can add knowledge about an "overlooked" lunar feature, knowledge that needs a confirmation on photographic images so we can reach a theoretical explanation (that we still don’t have).

7.-DO WE SEE MORE OR LESS THAN OUR PREDECESSORS?

It is likely that we will see more on the lunar surface than selenographers like Hevelius or Elger, we have in our internal encyclopedia all the data that almost a century of space exploration has generated and that much more distinguished observers than us, with many more years of observation, were unaware of, or they only intuited or deduced from a few observational data. It is our turn to try to get closer to these great colossi of astronomy and honor their memory by observing whenever we can.

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Willats, John (1990), The draughtsman’s contract. How an artist creates an image, in *Imagen y conocimiento. Cómo vemos el mundo y cómo lo interpretamos*, Crítica, Barcelona.
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A Tour of Copernicus and Pythagoras Craters

Jeff Grainger

Copernicus and Pythagoras: two spectacular craters, one very easy to observe, the other a bit trickier – with even half-decent views requiring a helpful libration.

The article that follows includes imagery taken with my C11, and from orbiting satellites (principally LRO and Kaguya). The LROC QuickMap tool has also been used to examine each crater in quantitative detail.

A short section at the end offers a brief comparison of the two craters, and makes us wish that Pythagoras was positioned more centrally on the Moon's surface than is the case!

Basic data, using John Moore's "Craters of the Near Side Moon":

Copernicus [see Moore, 154 CoM]:

Diameter: ~ 96 km

Age: ~ 800My old

Depth: ~ 3.8km (see later LRO profile data)

Pythagoras [see Moore, CoM 522]:

Diameter: ~ 145km

Age: Upper Imbrium period ~ 3.75 – 3.2 bn y old

Depth: ~ 3.5-4km (see later LRO profile data)

(1) A TOUR OF COPERNICUS

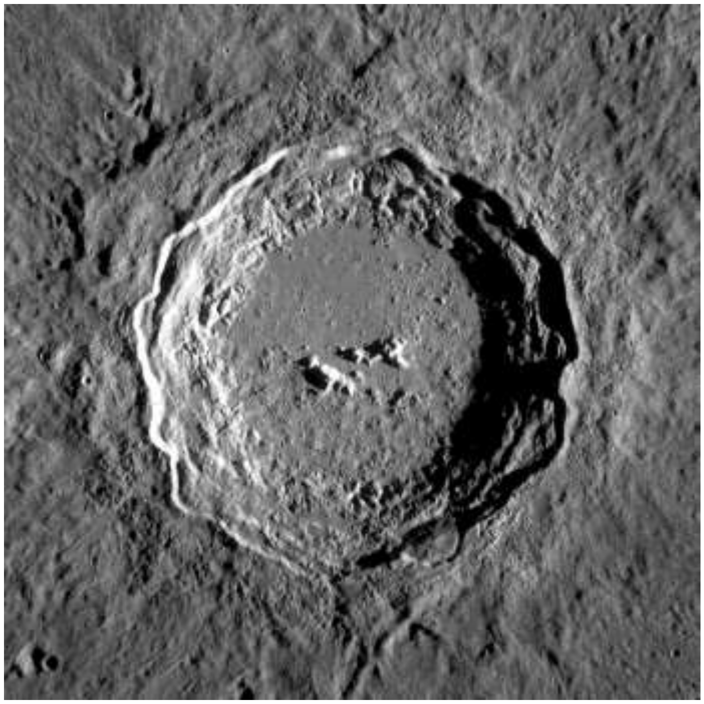
The following page shows a C11 image of the Copernicus area with an enlargement of the main crater area.

Image data: **Copernicus and Eratosthenes: 10.23 days 21.31 UT May 29 2023 [201]**

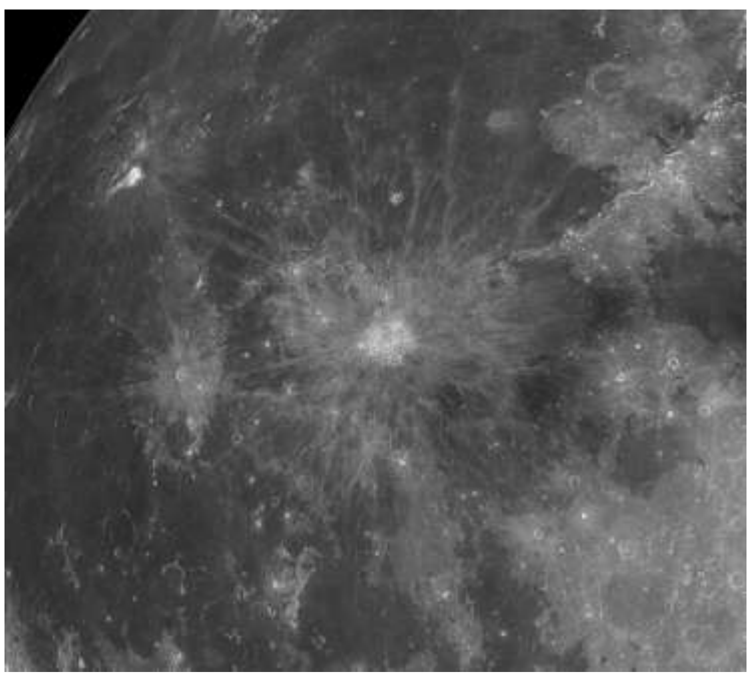
[Altitude: 33*02' Azimuth: 207*24' Libration: 5.6* @ PA 242*]

Compare these images – taken at a relatively low altitude (in the UK we have to take whatever opportunities are offered to us!!) – with the succeeding LRO image…..

Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters



Copernicus is a very "young" crater (by lunar standards!) and, like its compatriot Tycho, has an extensive ejecta ray system….



The ray systems of Copernicus and Kepler (to the west) as the moon approaches Full.

Note the difficulty of identifying craters that are prominent at other phases such as Eratosthenes, Archimedes and Ptolemaeus.

Image taken at 14.0 days, 22.49 UT December 07, 2022 [CopR 140

Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters

The following image shows the extent of the rays at a slightly younger phase: the 12.0-day old moon.

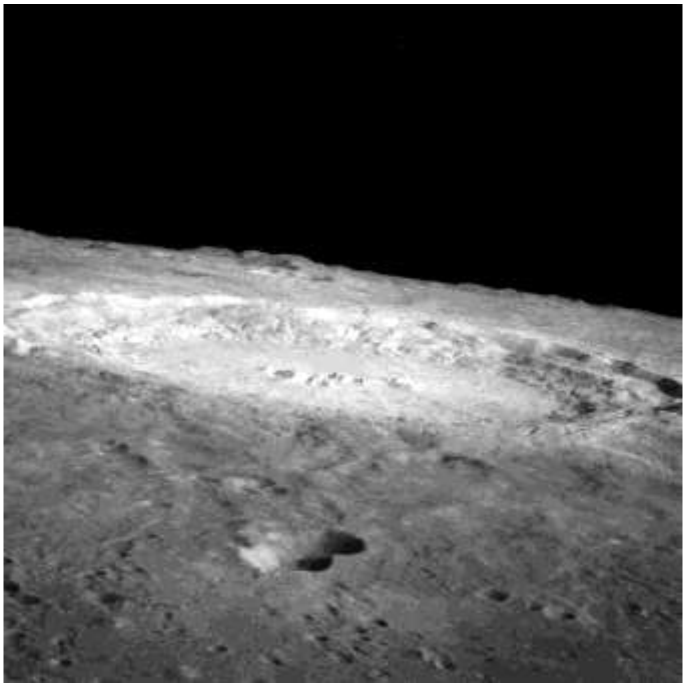
The rays are nearly as extensive as near Full Moon, but the "obliteration" of craters such as Archimedes isn't quite as extensive.

Image taken at 12.0 days, 22.47 UT December 05, 2022 [CopR 120]

Further Satellite Imagery:

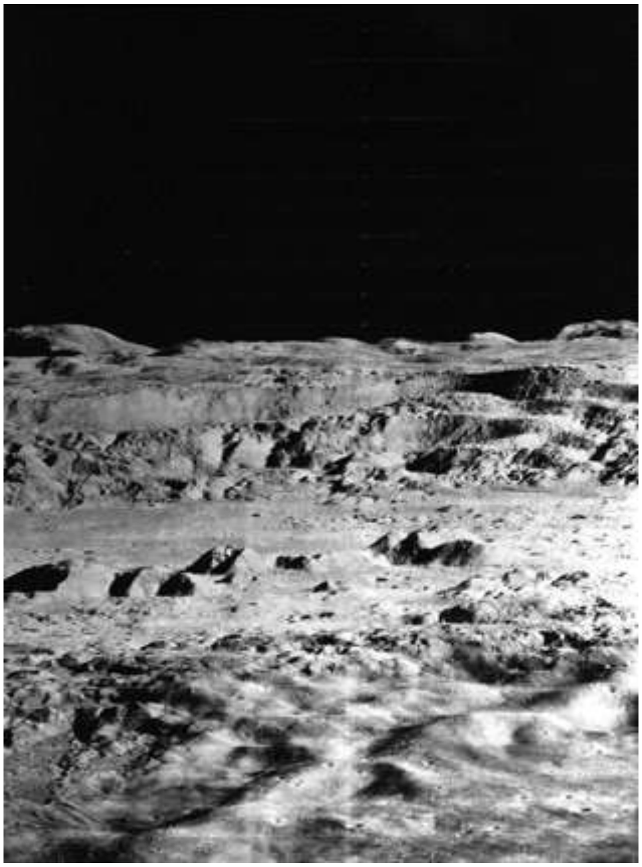
From a terrestrial viewpoint, craters such as Copernicus can appear to be very deep enclosures in comparison to their diameters. Satellite imagery clearly illustrates the "shallow bowl" aspect of many of these features.

The upper photo on the next page is an oblique view of Copernicus taken by Apollo 12 in 1969 [ref. AS12-52-7739]. The view is looking North, Fauth crater is in the foreground.

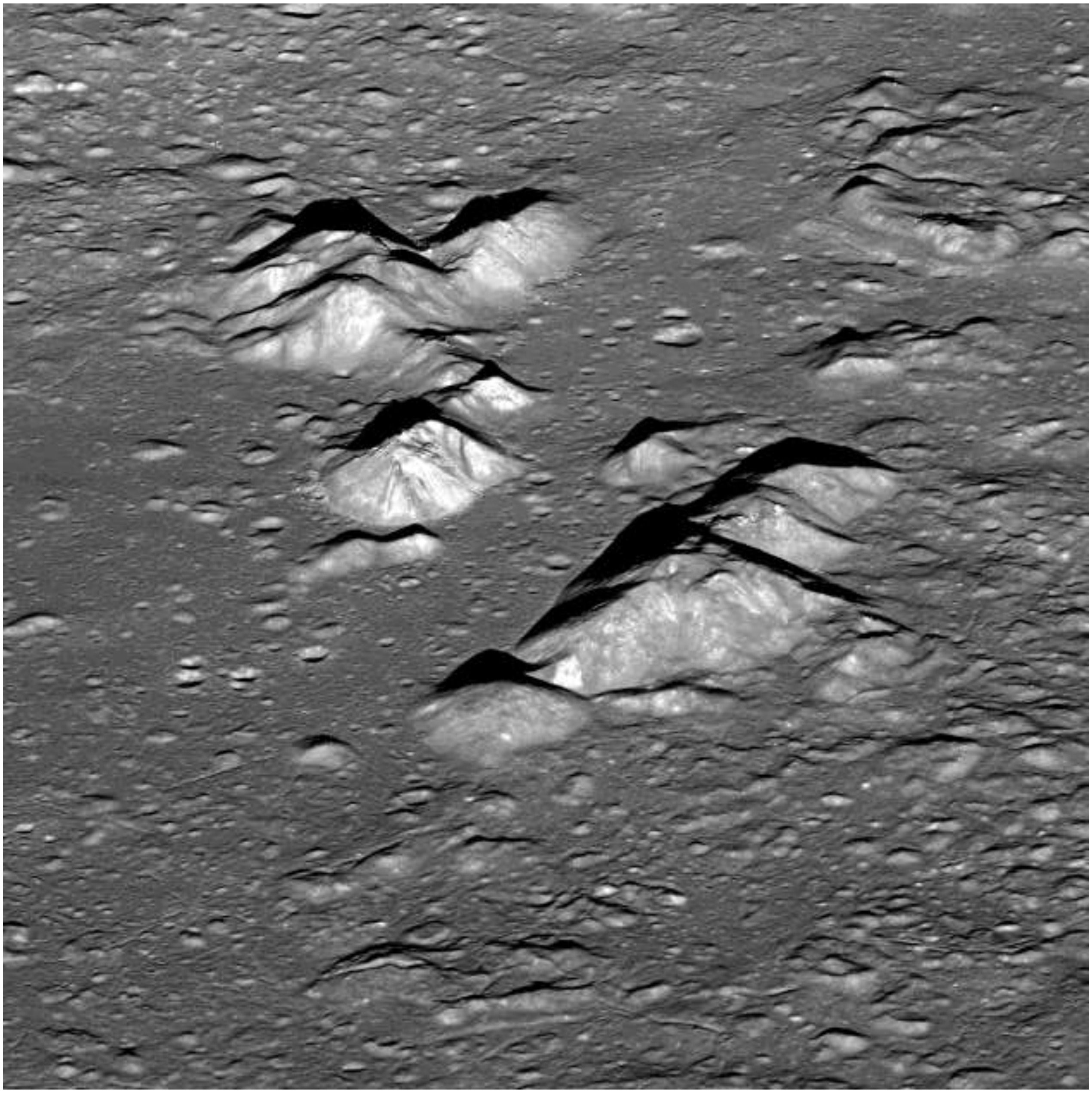


The image, below, is an oblique view of Copernicus, taken by Lunar Orbiter 2.

At one time this was dubbed the “Picture of the Century”. Both crater rims and the central peak system are clearly shown.



Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters



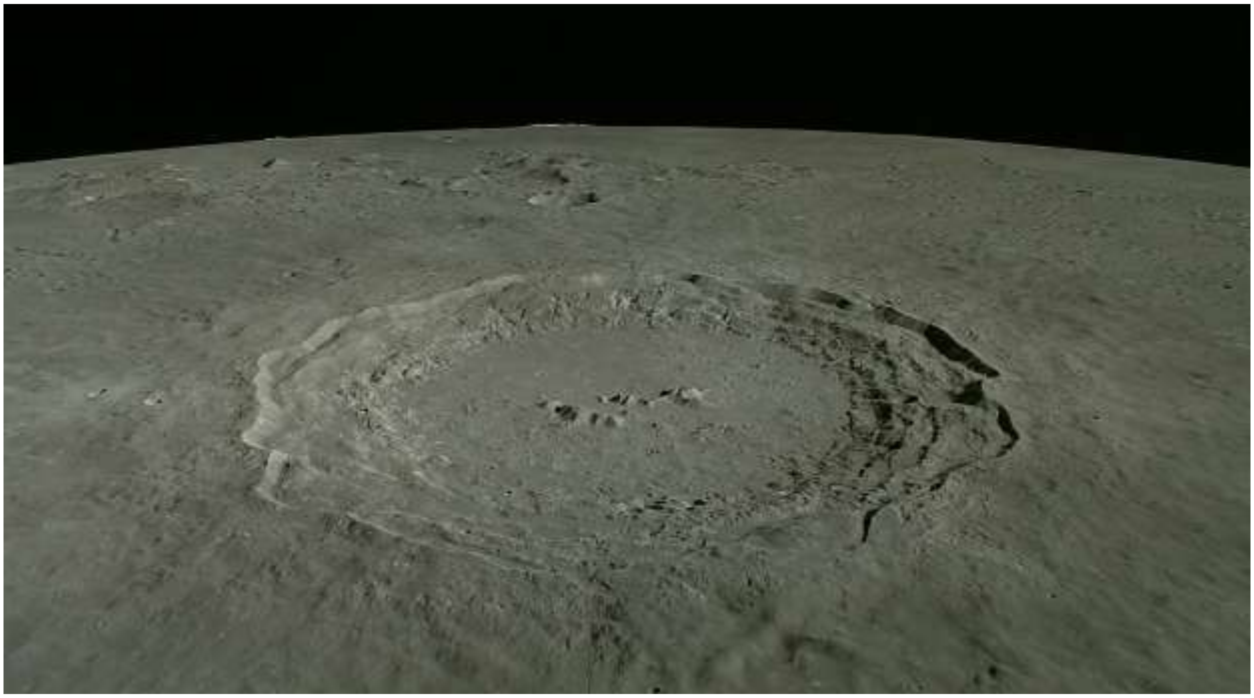
LRO imagery of the entire central-peak complex…

….. this view is looking east.

The top image (see below) was taken from a JAXA/NHK Kaguya.

The top image is a straight video grab. The lower image has been curves-enhanced to improve the contrast.

NOTE how shallow the crater looks compared to the Earth-based impression of a deep "pit". The Profile data at the end of this document shows the average angle of the Copernican terraces to be around 1 in 4.5 – about 12 degrees (not too steep!)



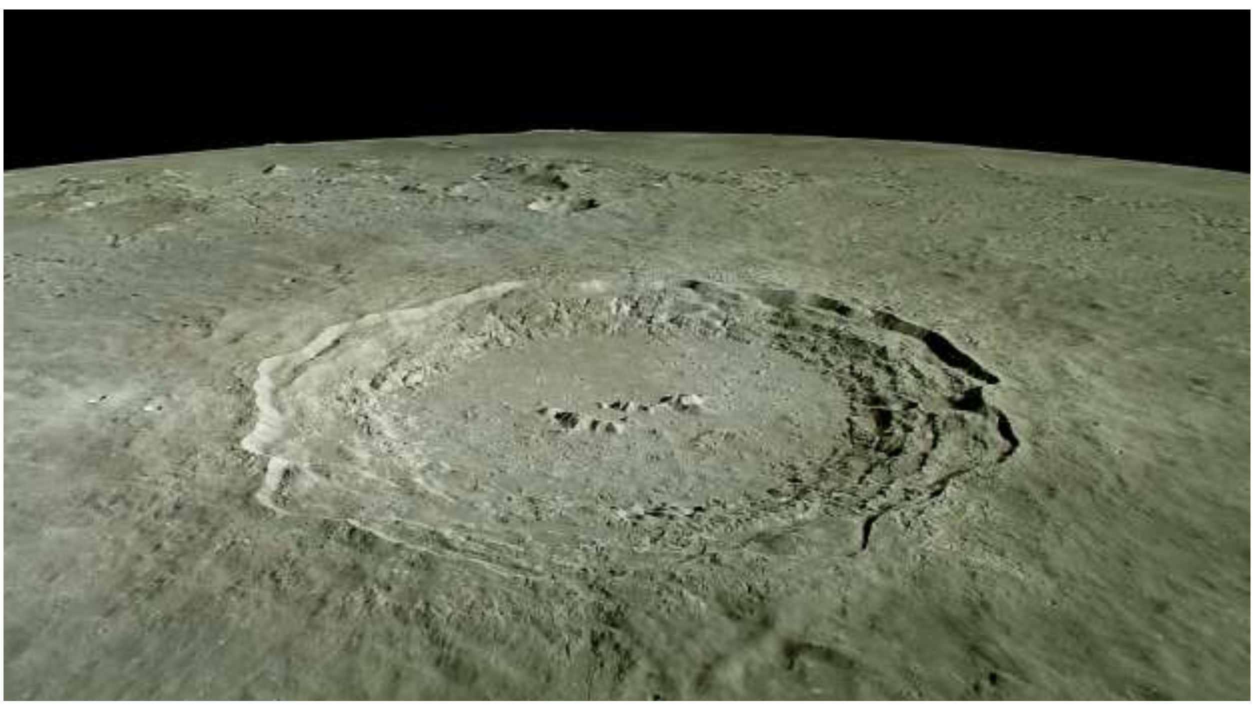
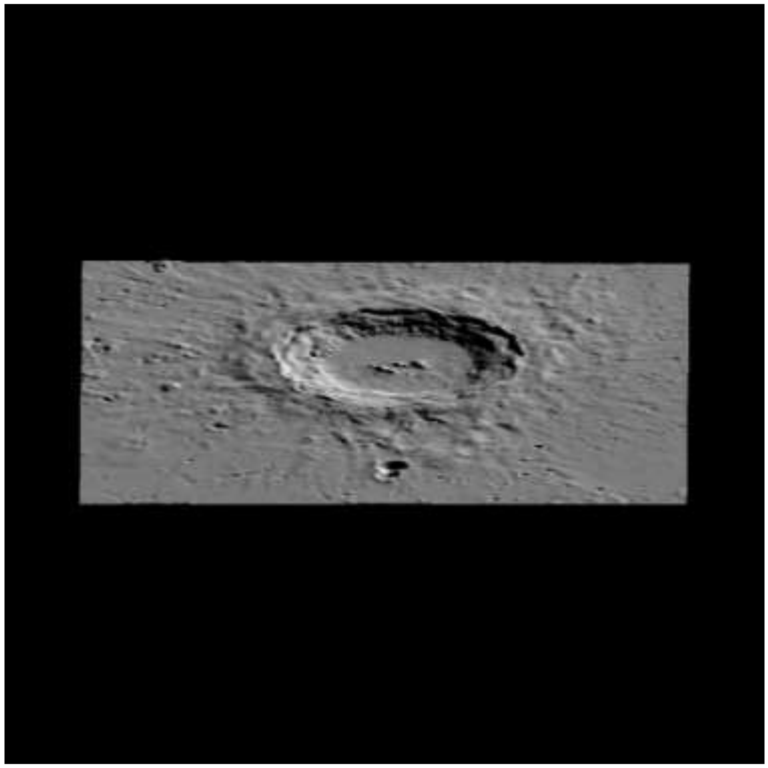
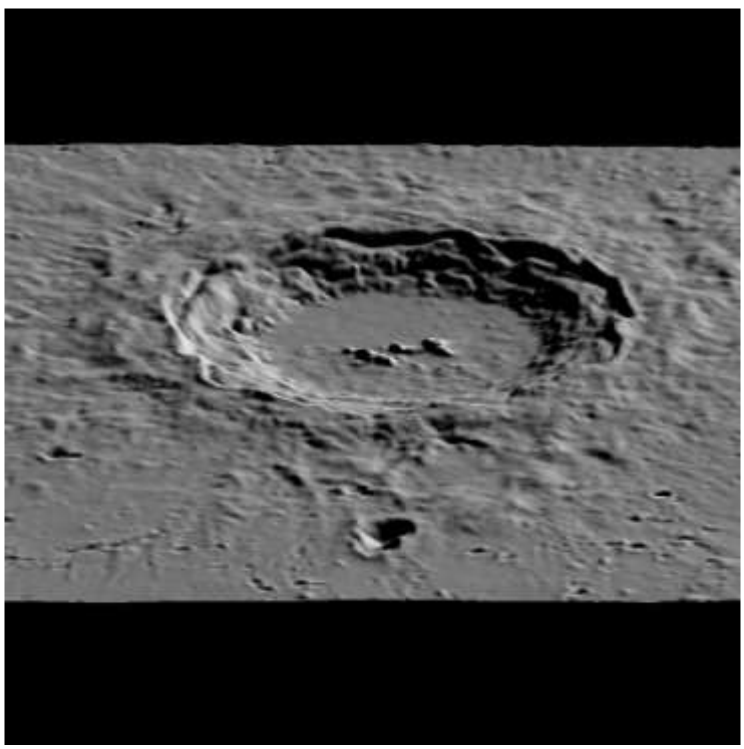


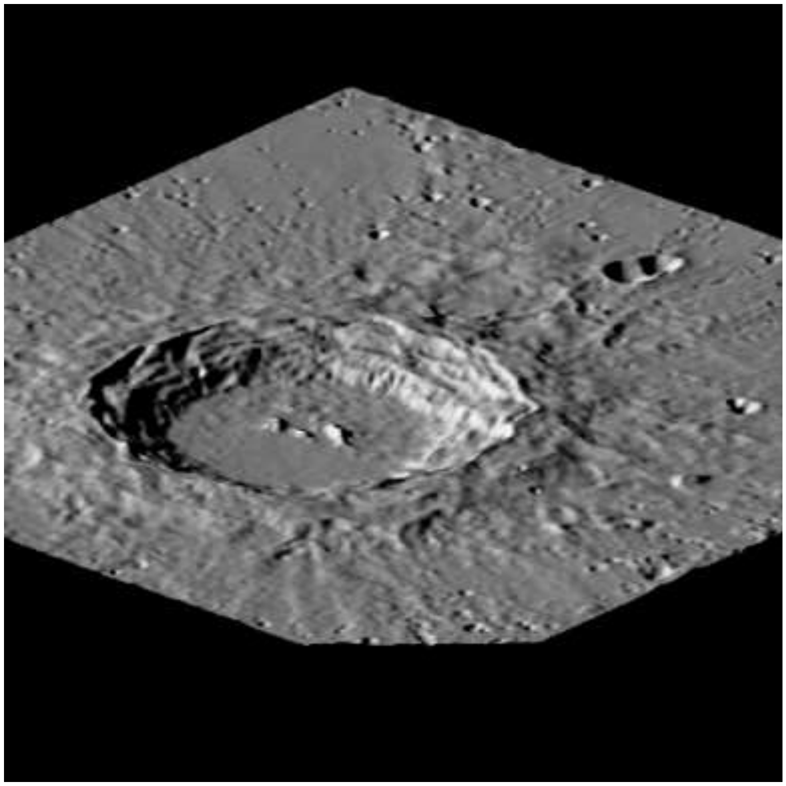
Image Rendering (using QuickMap data):



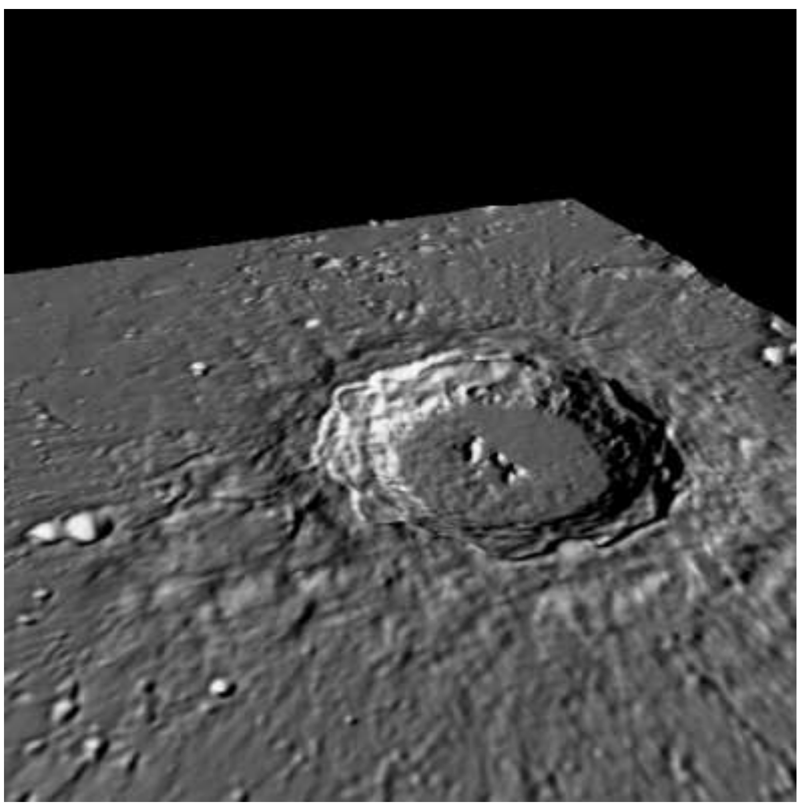
Looking north, no vertical enhancement.



Looking north, zoom and exaggeration x2



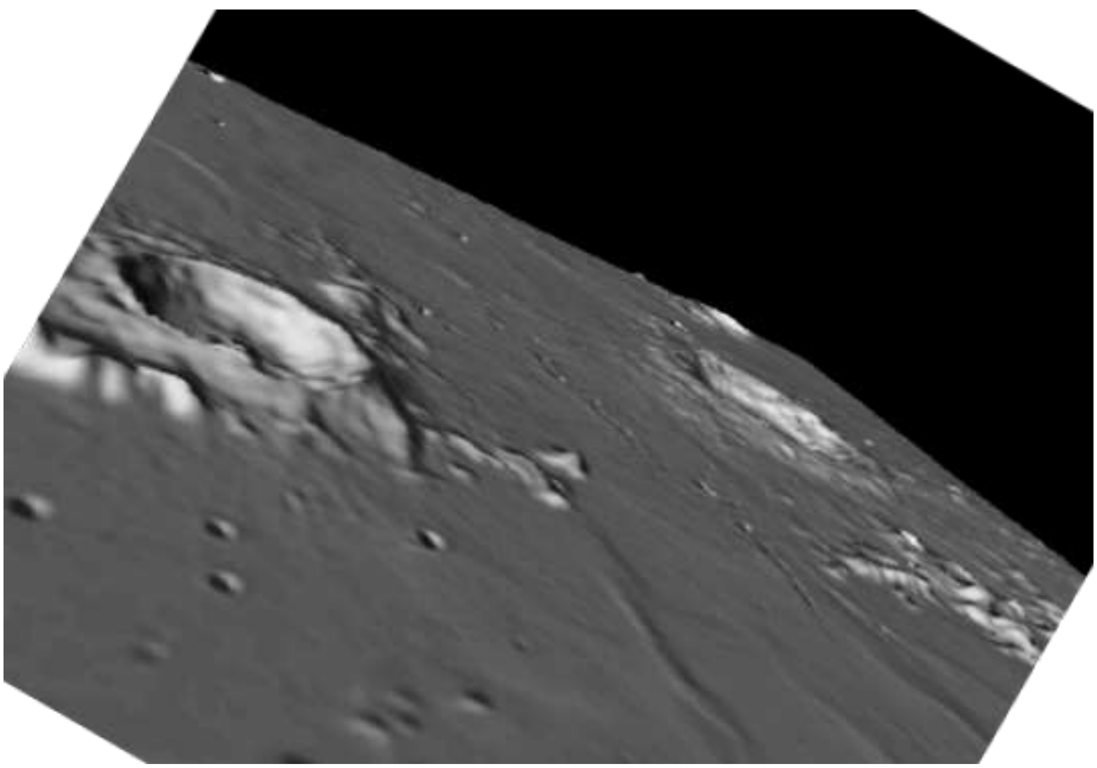
Looking SE. Zoom and vertical enhancement x2.



Looking NW, Ex 2 zoom.

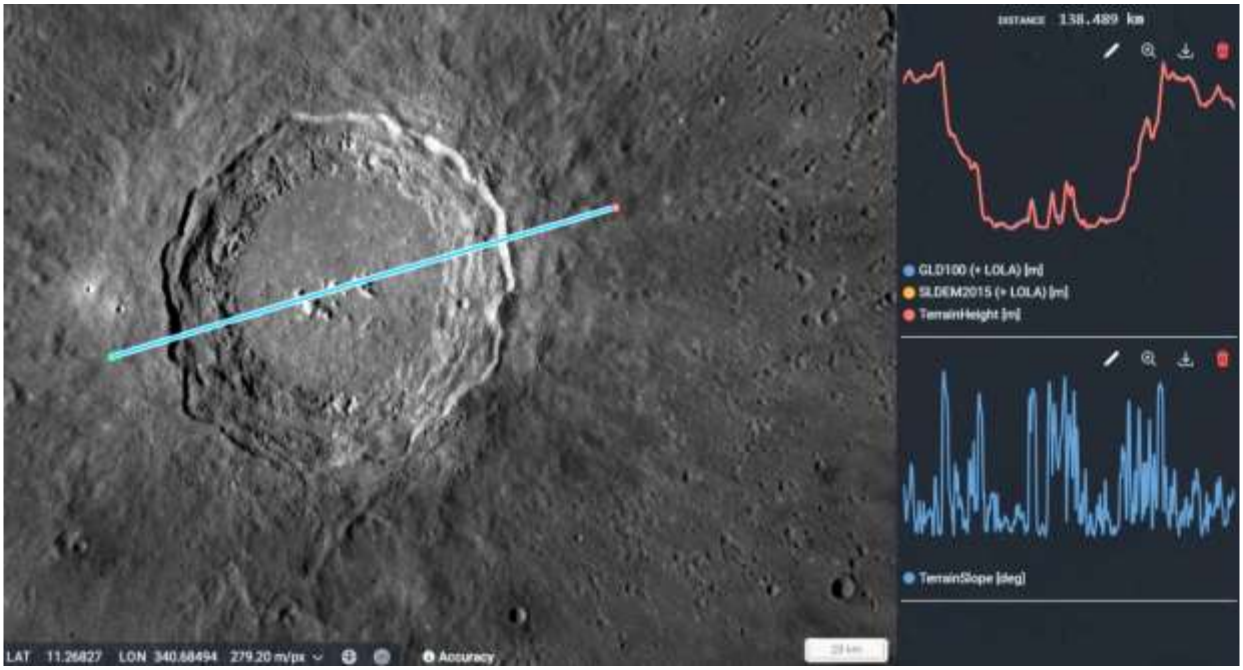
There is a very well-known image showing Copernicus crater (on the horizon) as viewed overlooking Eratosthenes (Apollo 17, AS17-145-22285).

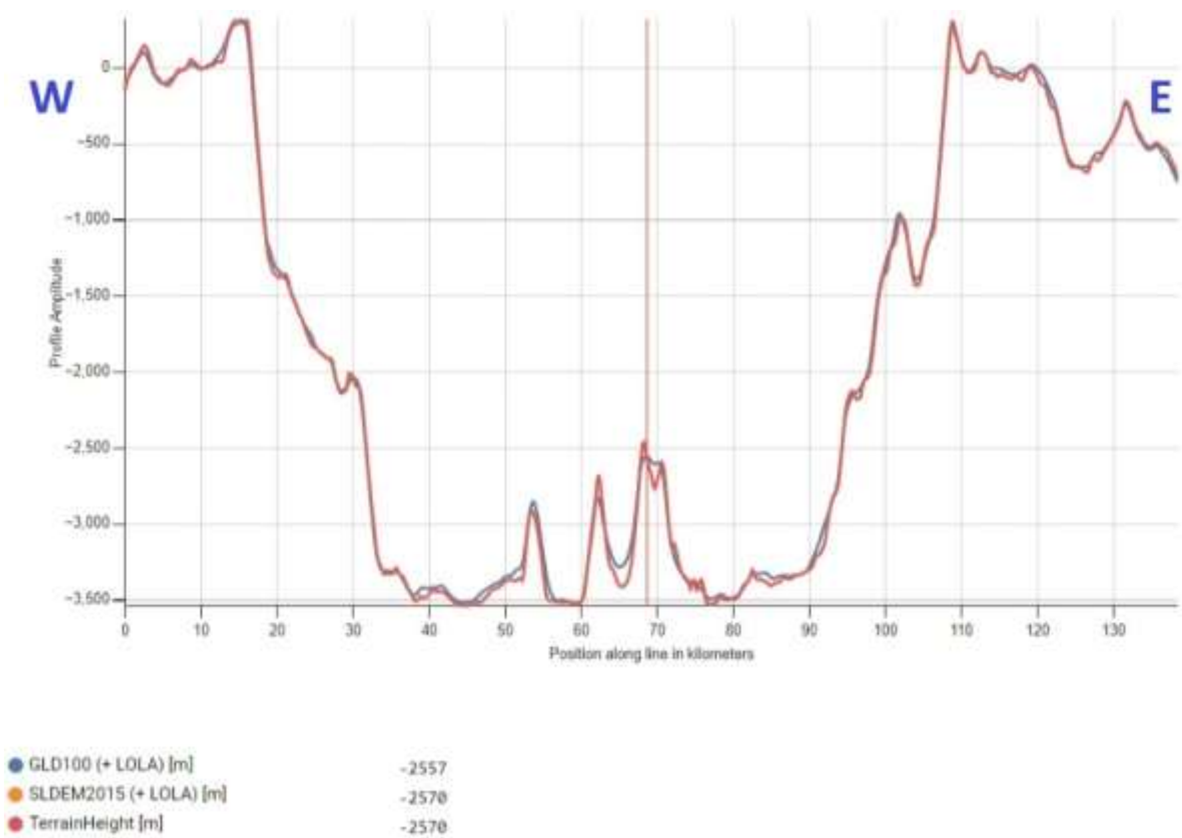
Here's my take on things: Zoomed, vertical exag 3 and rotated (Perspective view).



Crater Profiles:

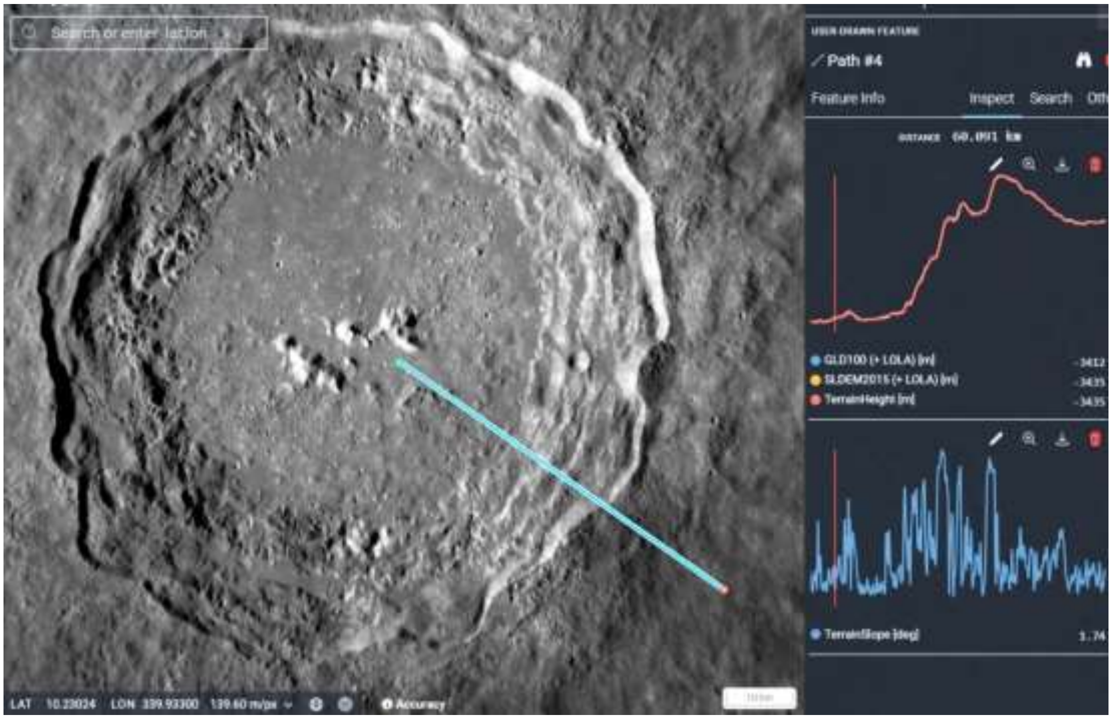
Profile ~ W-E through the central peak system:

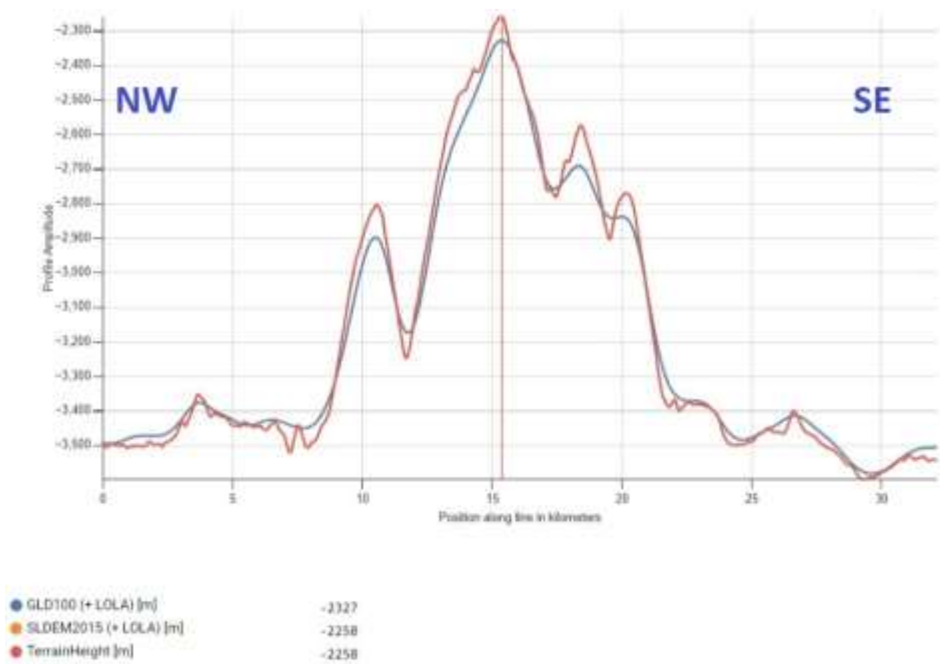




Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters

Profile through the western group of peaks:

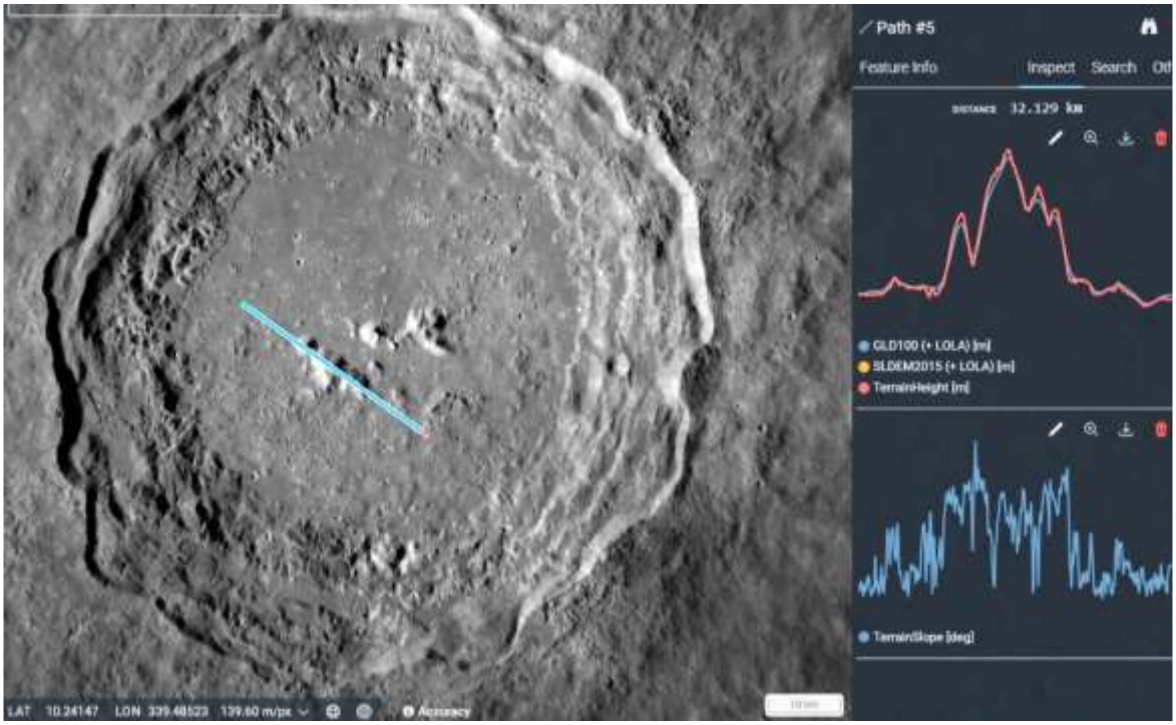


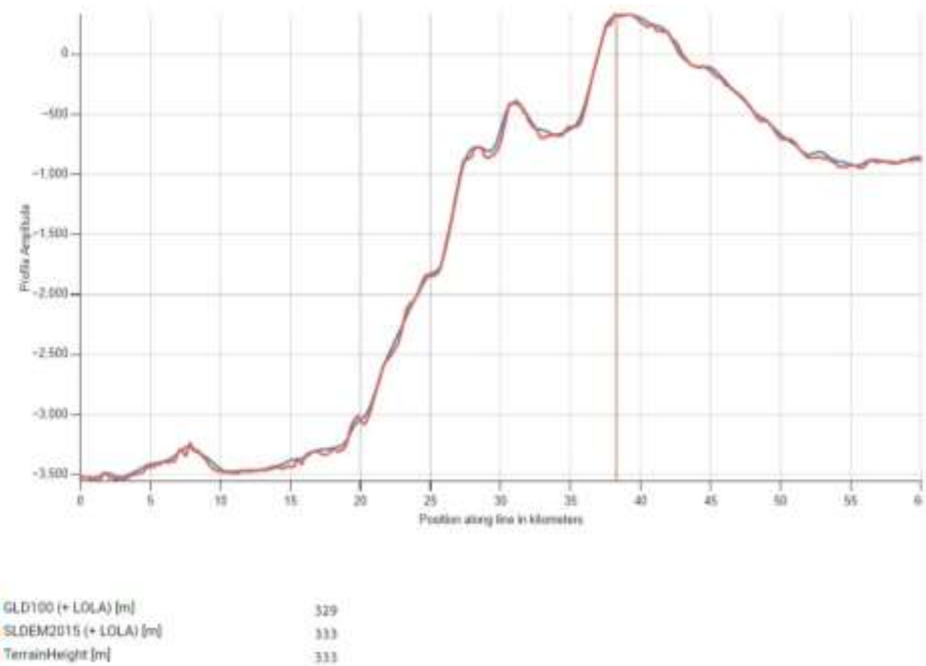


The profile data – and the imagery - show that the central peak system of Copernicus is much lower than that of comparable craters, a mere 1000-1200m (compare with Theophilus at ~ 2500m).

The profiles suggest that this is because the internal crater depth is over 1000m shallower (rim to floor) – caused by internal lava up-welling in the past?

Profile of SE terrace:



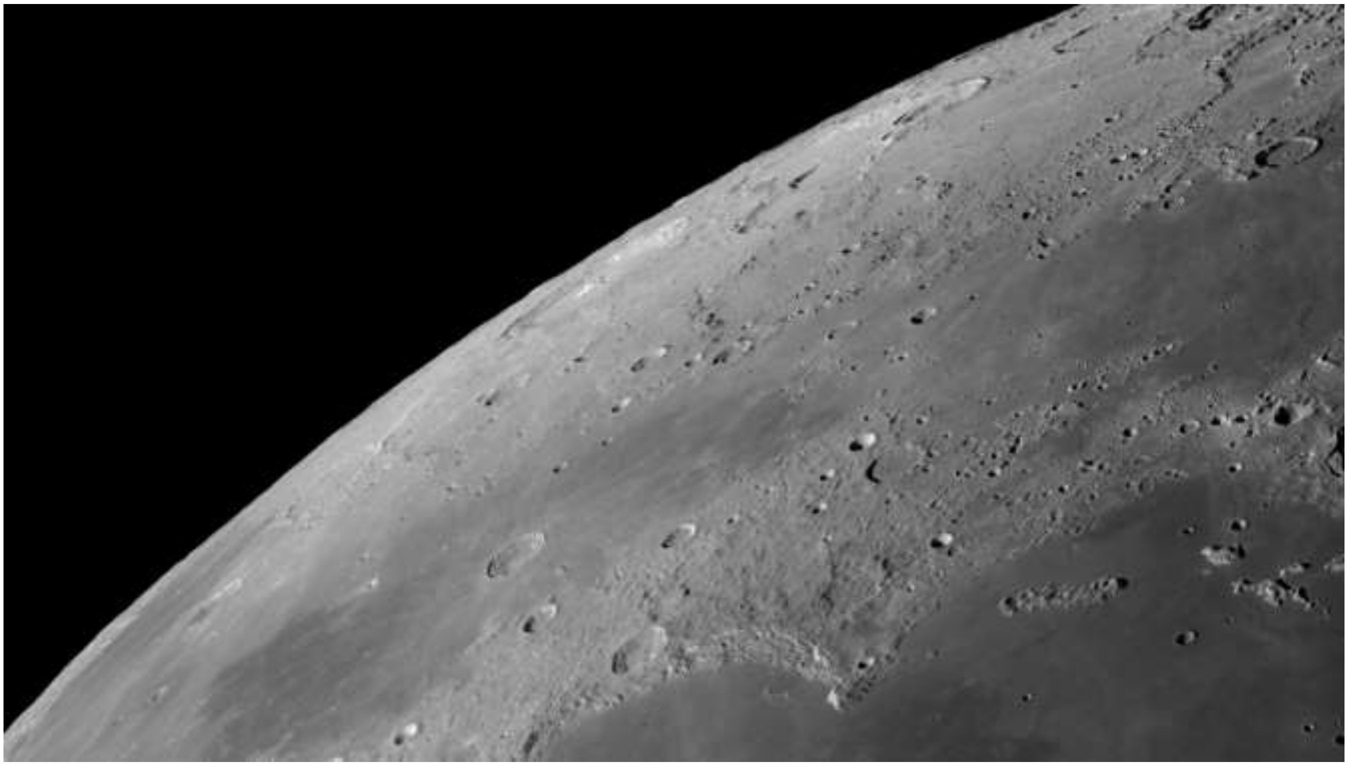


The average slope of the SE terrace is around 1 in 4 to 1 in 5, in keeping with comparable sized formations.

(2) A TOUR OF PYTHAGORAS

Located in the far NW of the Moon, this spectacular crater is never seen from Earth at more than a fraction of its best. But satellite imagery reveals it in all its glory.

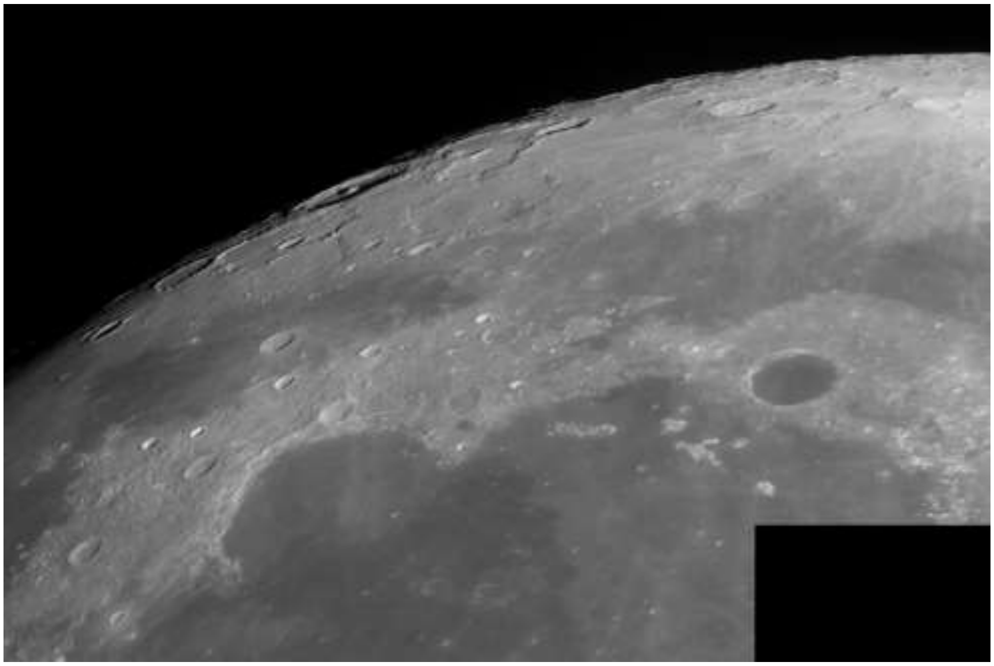
To put this crater into true perspective, see the Comparison with Copernicus section!



Sinus Roris and Pythagoras: 20.79 days 03.12 UT September 17 2022 [37]

[Altitude: 51*33' Azimuth: 126*05' Libration: 5.1* @ PA 125*]

Above: Pythagoras near the NW limb of the waning moon. Even in this highly oblique view, the terraced walls and central peak system of the crater are apparent.



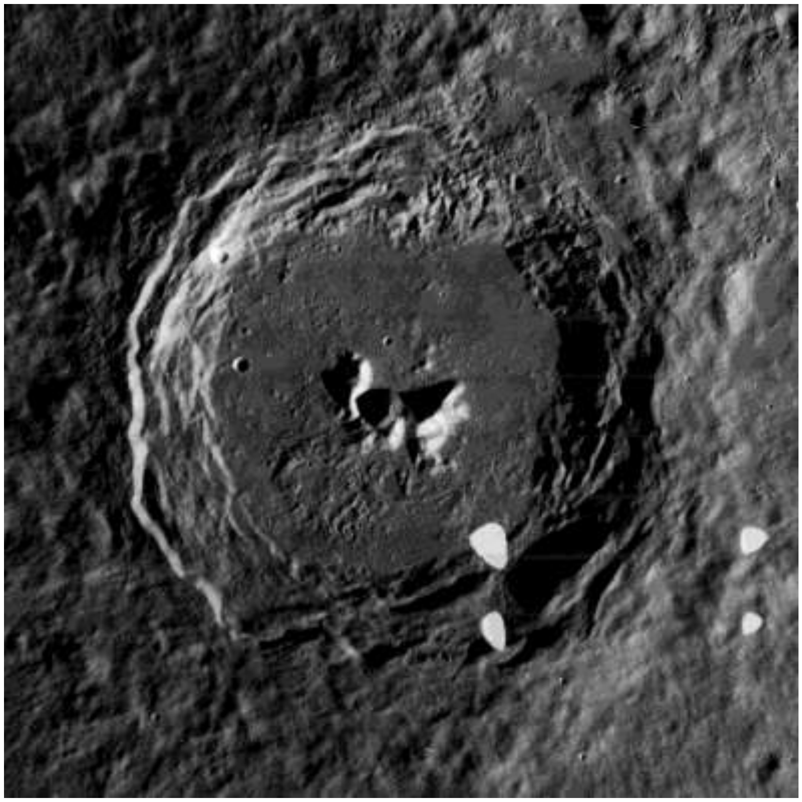
The central peak system is prominent at local sunrise with the crater on the terminator:

(Top) April 03 2023 22.10 UT [156]   (Bottom) December 06 2022 23.32 UT [100]

Libations: (Top) 5.2* @ PA 213*   (Bottom) 4.6* @ PA 112*]

Satellite Imagery:

Overhead view of Pythagoras from Lunar Orbiter 4: Pythagoras_crater_4176_h1_4176_h2

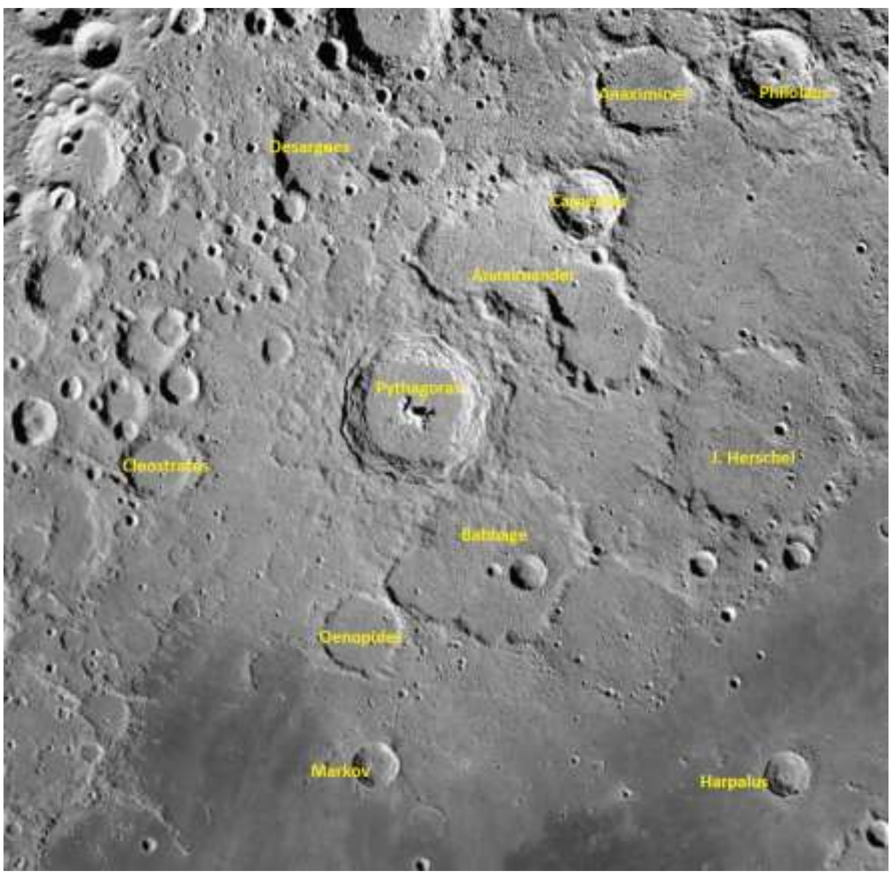


The white “splodges” are artifacts in the transmitted image**.**

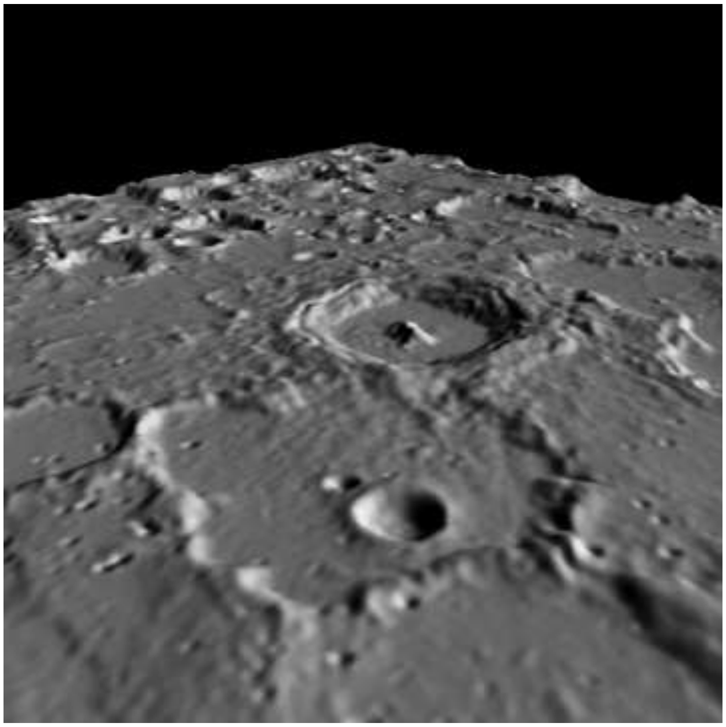
Oblique view from the Kaguya orbiter. Note Babbage in the background.

A slightly different angle on the central peak, with Babbage to the rear. Again, a contrast enhancement has been applied.

<u>Image Rendering:</u>

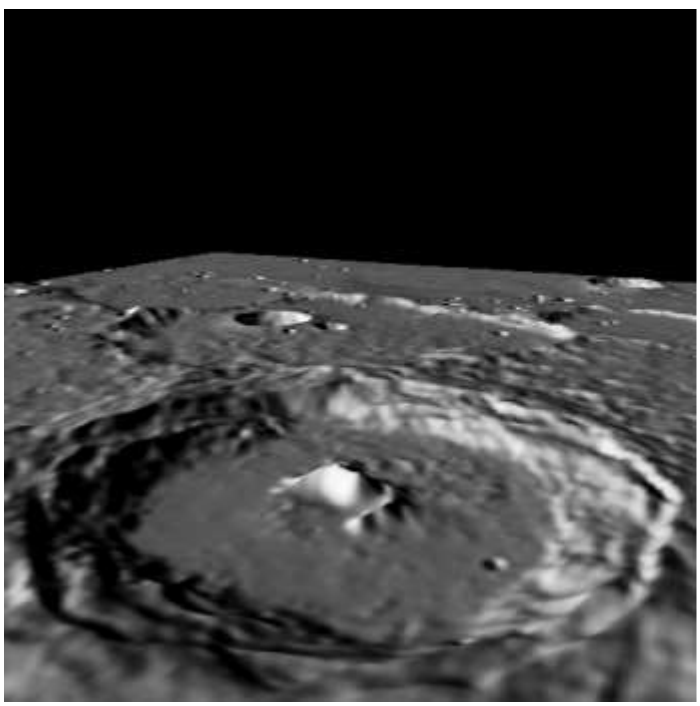


This is a relatively unfamiliar “corner” of the lunar landscape, so here’s a guide to the area…



Looking NW over Babbage and Pythagoras. Perspective view, vertical exaggeration x 3 and zoomed.

Pythagoras may be > 3 billion years old, but the degradation in crater rims and shape show Babbage to be much older.

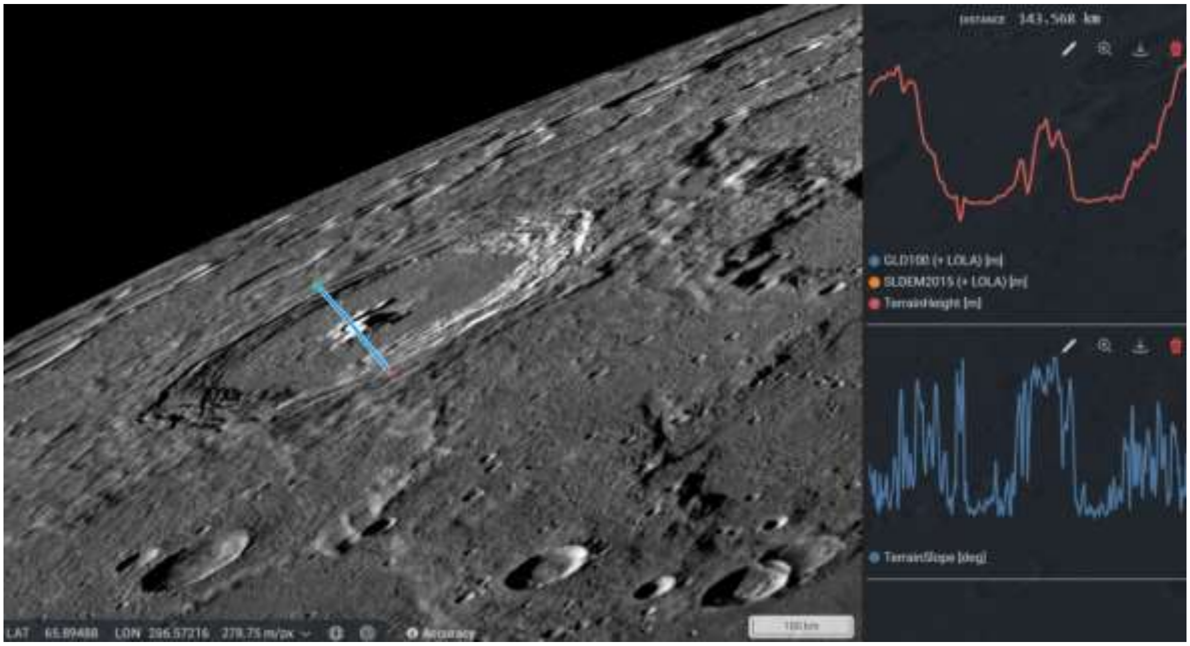


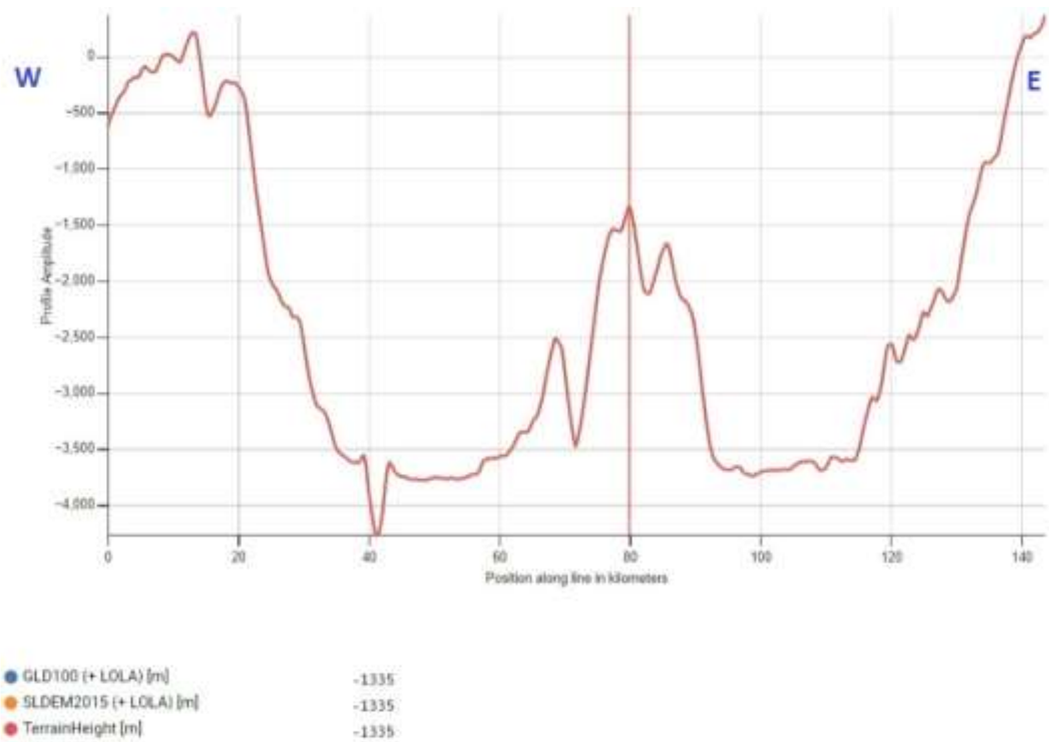
Looking NE with the degraded Anaximander crater in the background.

Perspective view, x3 and zoomed.

Crater Profiles:

From W to E:

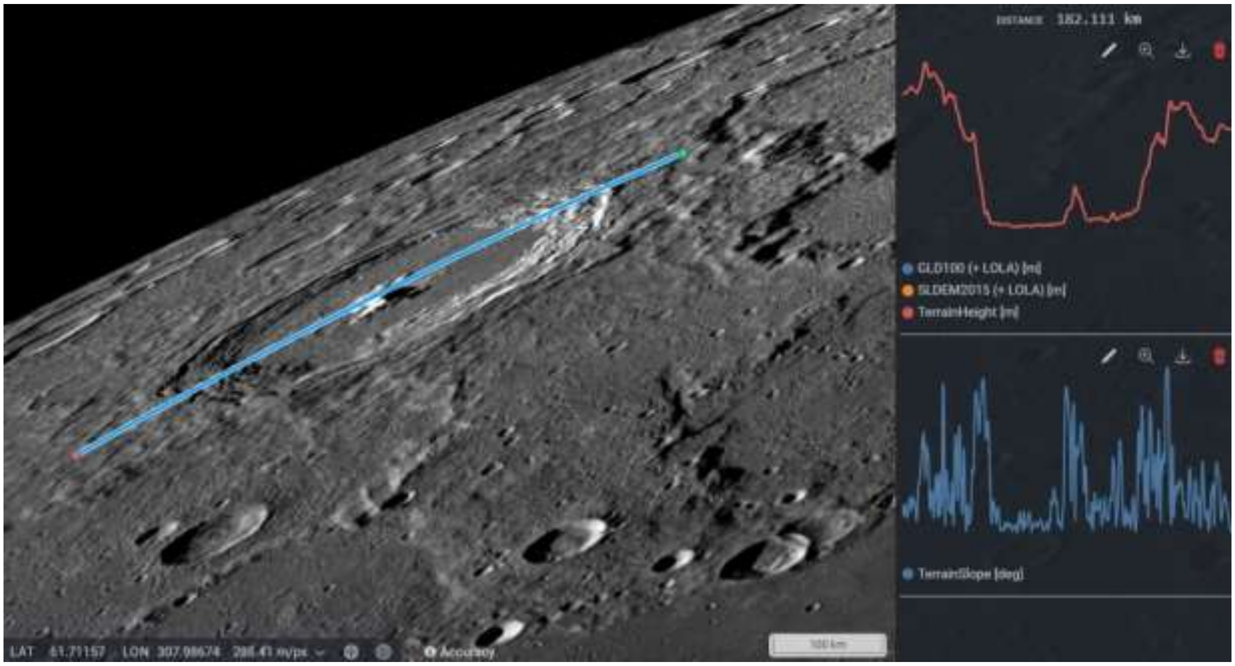


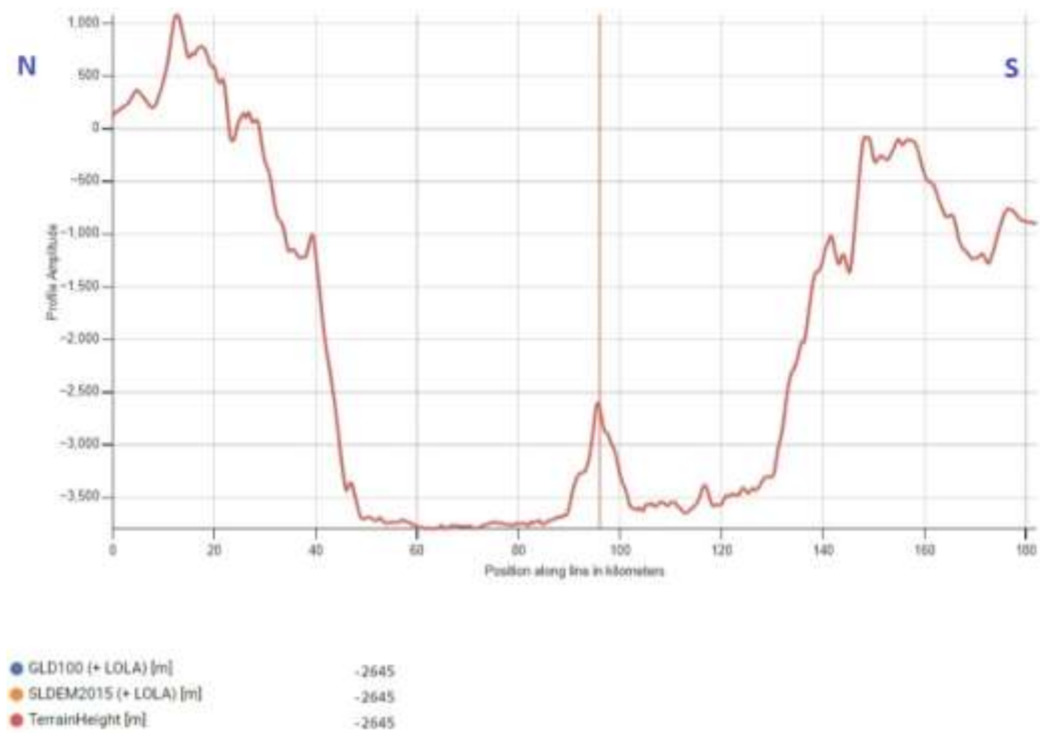


The central peak system is substantial, reaching heights of up to well over 2 km above the crater floor.

Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters

From N to S:

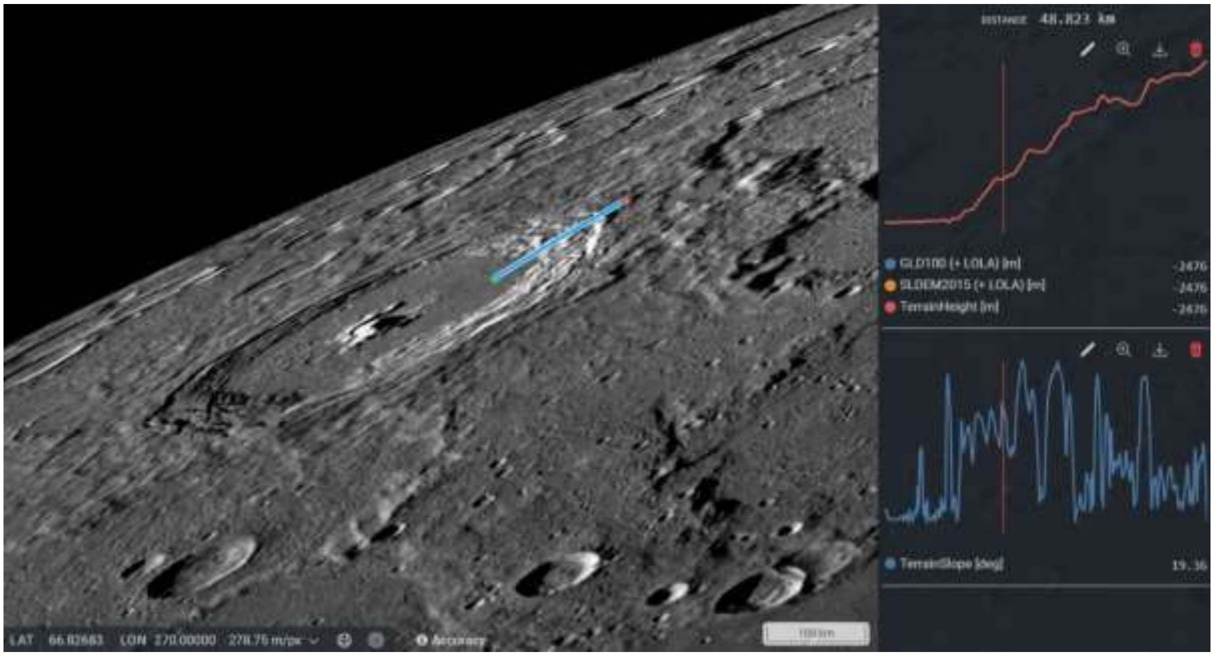


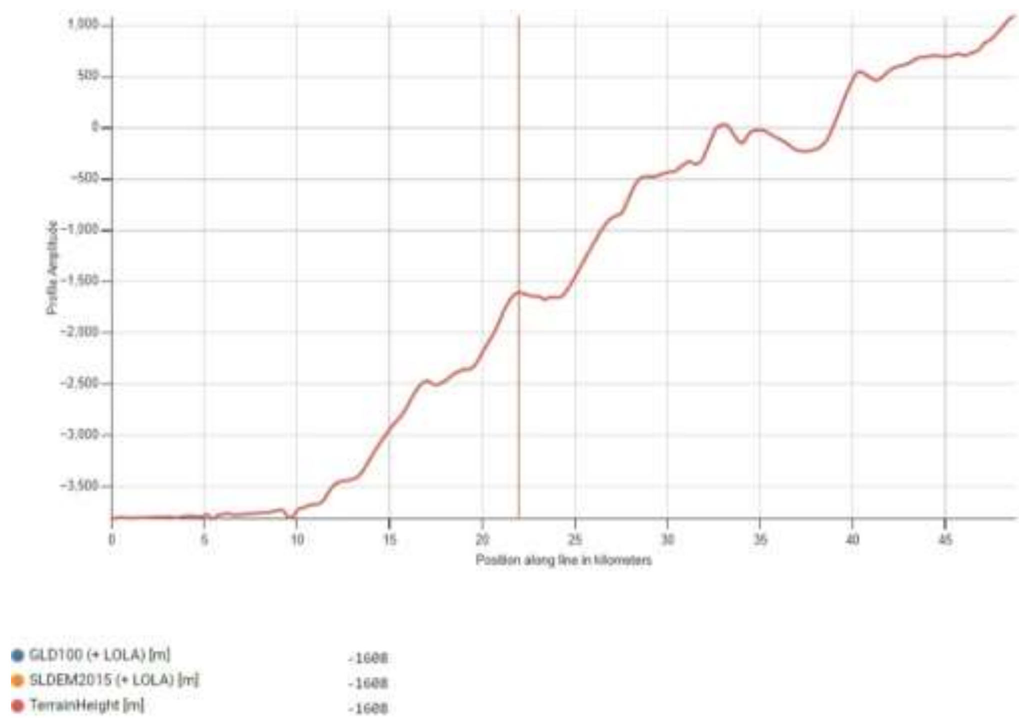


There's a clear asymmetry here between the level of the rim ejecta from the N side to the S side.

Lunar Topographic Studies
A Tour of Copernicus and Pythagoras Craters

Terrace slope: A cross-section from central peak up through the N terraces….

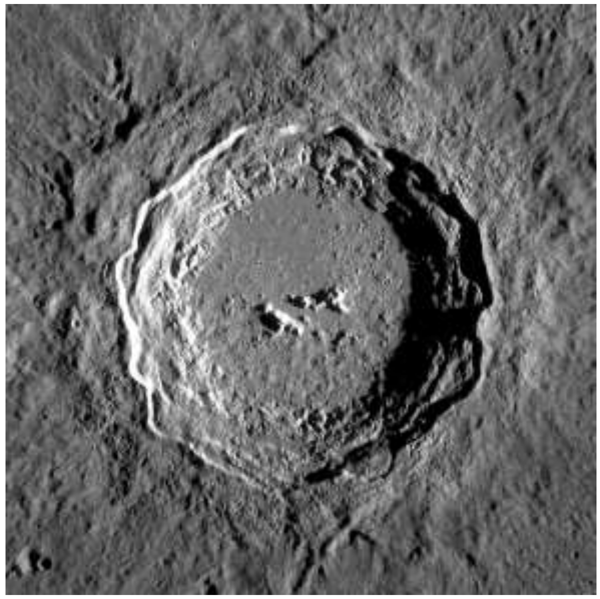




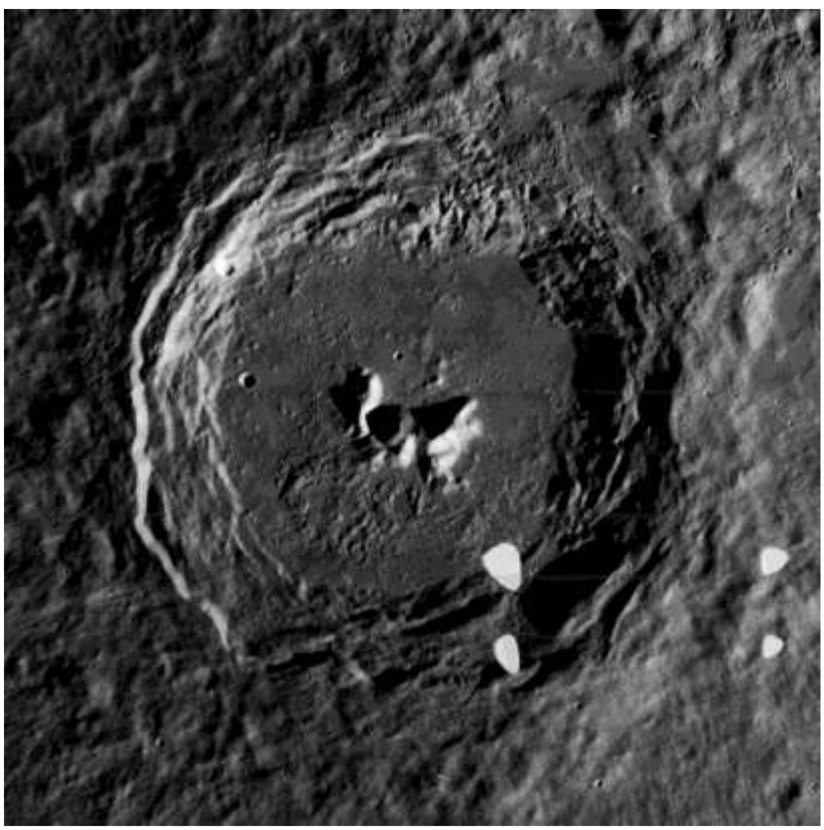
The N terrace rises around 4km over a distance of 40km, so an average slope of 1 in 10. Relatively gentle at around 6 degrees.

Pythagoras vs Copernicus:

Comparison in size: The two craters are reproduced to the same scale….



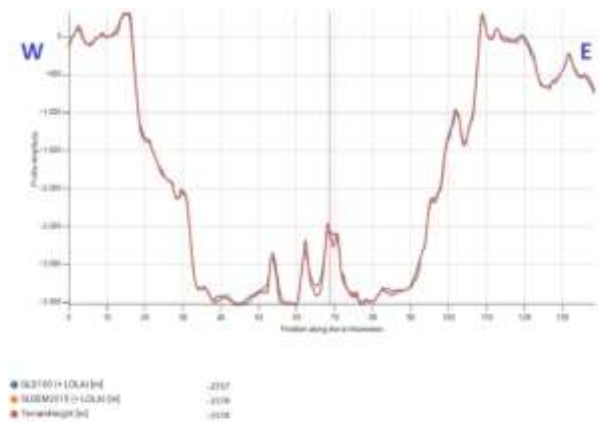
Copernicus: Diameter 96km



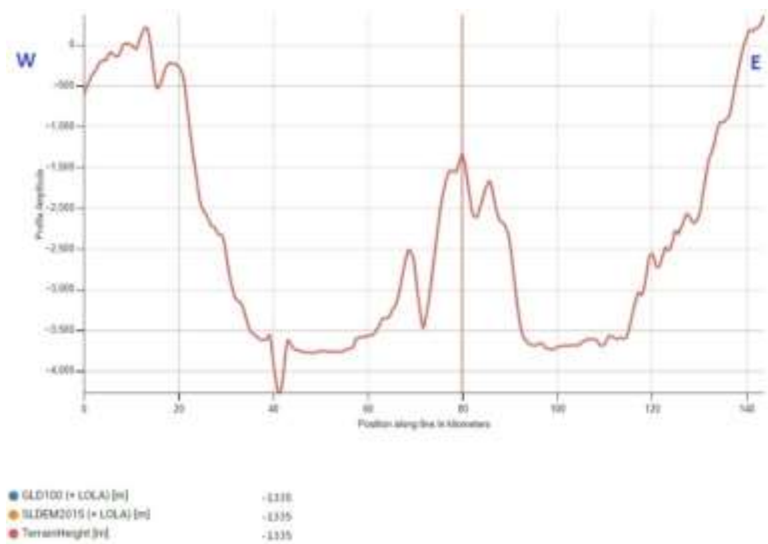
Pythagoras: Diameter 145km

Comparison in depth and central peak:

Copernicus: Depth ~ 3.5km, Central Peak ~ 1.0km (max)

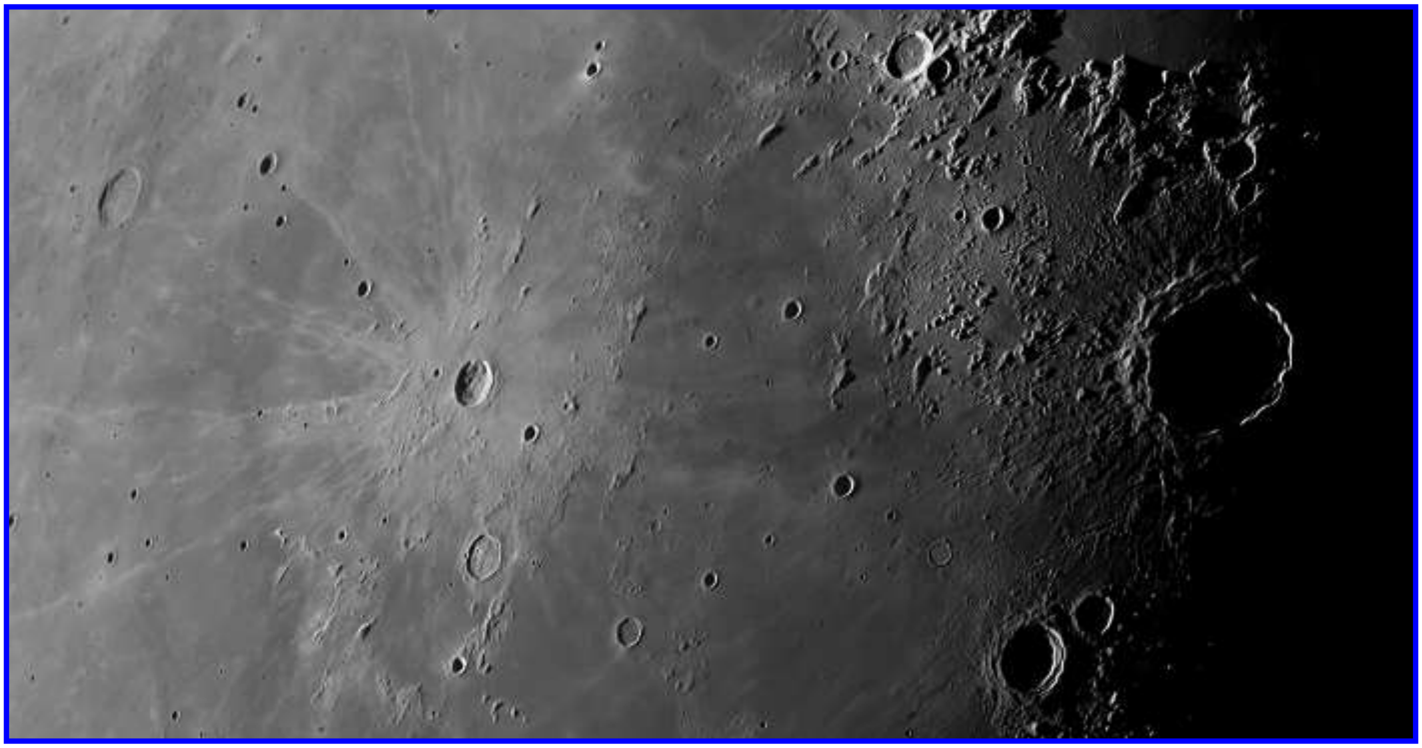


Pythagoras: Depth ~ 3.8km, Central Peak ~ 2.4km (max)



The two profiles are reproduced to the same scale.

Pythagoras is 50% wider, 300m deeper and its central peaks are nearly 1.5km taller than those of Copernicus. Copernicus is a magnificent crater. What does that make Pythagoras?



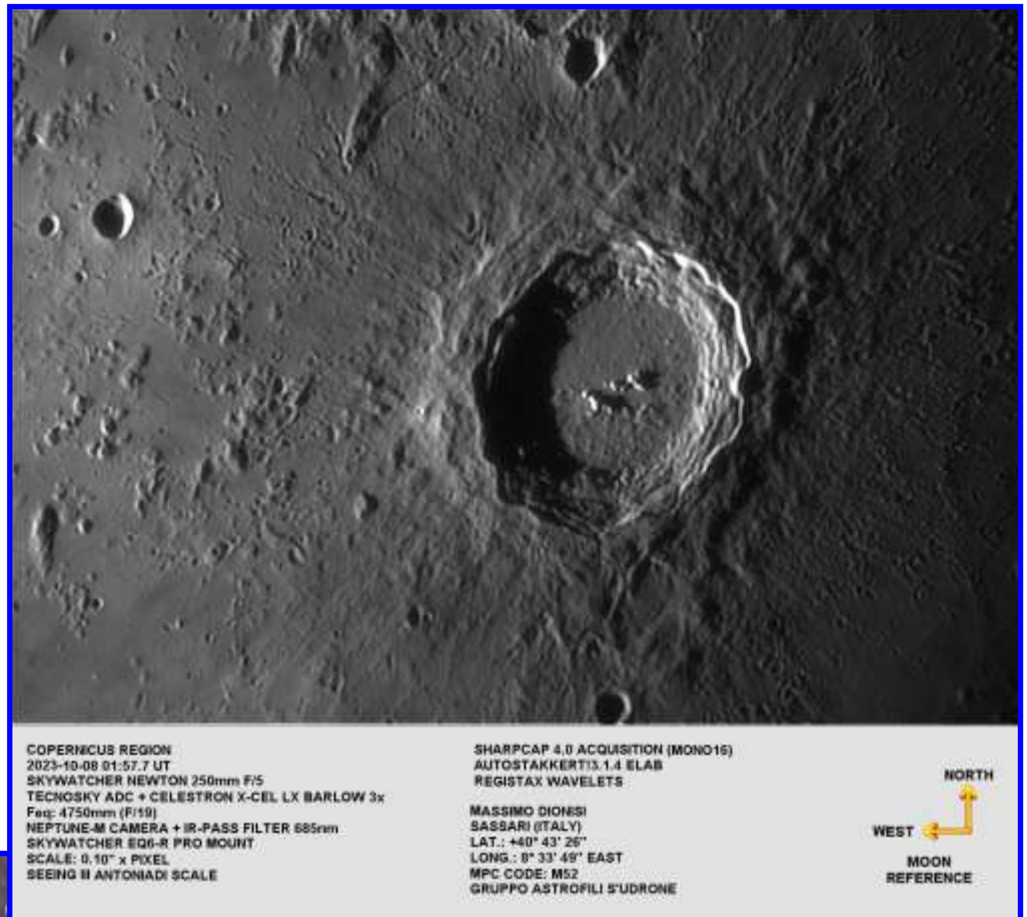
Kepler to Copernicus, *Fredrick toe Laer, J. Bresser Observatory in Borken, Germany. 2023 September 09 04:03 UT. 16 inch Schmidt-Cassegrain telescope, ZWO ASI290mm camera. Fredrick adds* "Again a Panorama, this time made from 8 panels. It shows sundown over Copernicus, whilst the Lunar day is still in full swing on Kepler. I find the size of Copernicus staggering, compared to Kepler. I have never been a big Dome observer, but in this image the light is such that many domes come out beautifully in the plains between Copernicus and Kepler. The light does not show Rima Milichius well. Interesting to note that this is one of the few maps (30) in Rükl's atlas, where both a Greek denomination for an elevation is noted (Milicius Pi) as well and three double lettered features (Hortensius DA, DB, DD). What happened to DC one would ask? In the Atlas and Gazetteer of the Nearside of the Moon, Map 133-1 Notes DC to be the craterlet at about 11 o'clock from Hortensius D at the same height of DA."

Recent Topographic Studies

Bailly, *Maurice Collins, North Palmerston, New Zealand. 2023 November 26 09:57 UT. FLT 110 mm refractor telescope, QHY5III462C camera.*

Horrebow and Horrebow A, *István Zoltán Földvári, Budapest, Hungary. 2019 April 15 20:26-20:42 UT, colongitude 42.0°. 70 mm refractor telescope, 500 mm focal length, Vixen LV Lanthanum 4 mm, 125x. Seeing 6/10, transparency 6/6.*

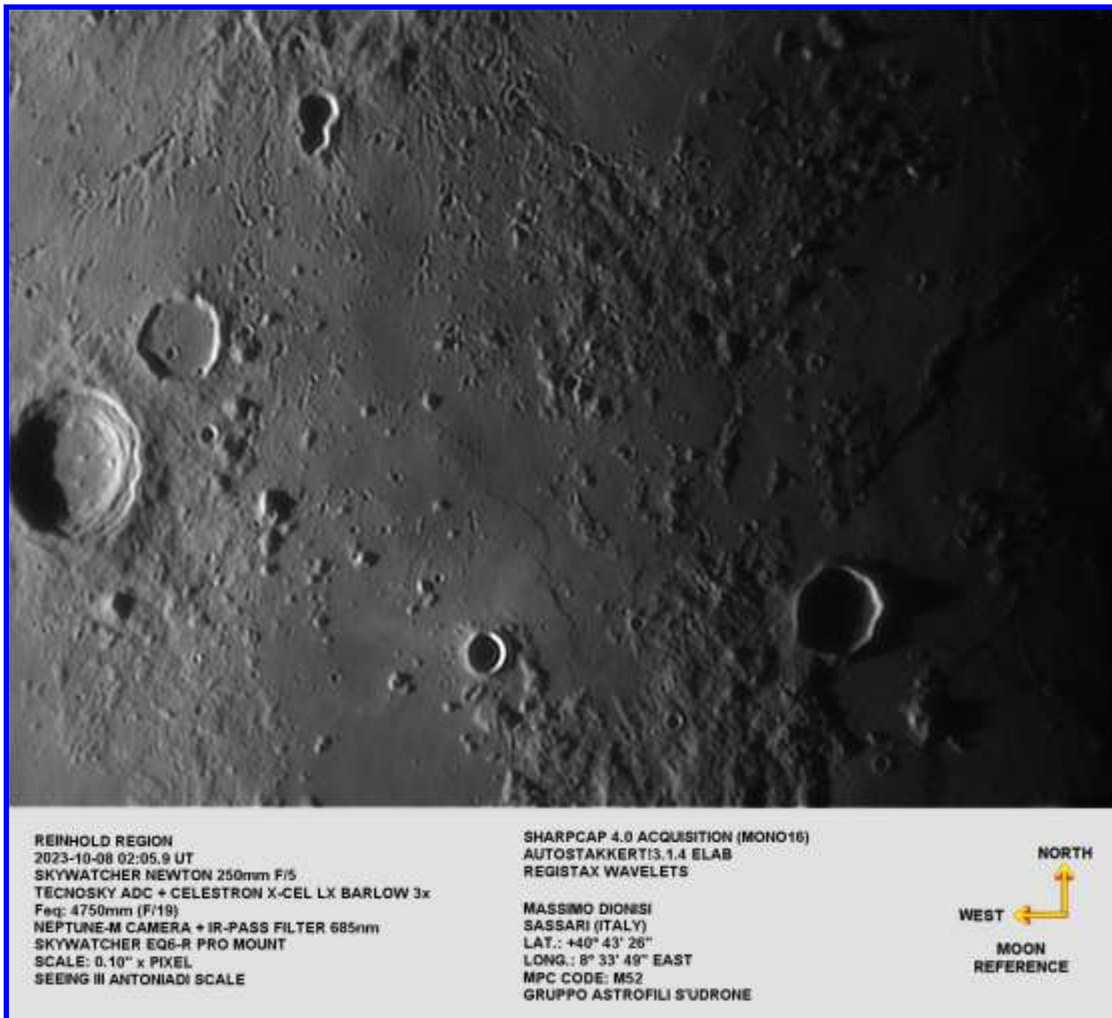
Recent Topographic Studies



***Copernicus,** Massimo Dionisi, Sassari, Italy. 2023 October 08 01:57 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X-cel LX Barlow 3x, fl 4,750 mm, IR Pass filter 685 nm, Neptune-M camera. Seeing III Antoniadi Scale.*

***Oceanus Procellarum,** Maurice Collins, North Palmerston, New Zealand. 2023 November 26 09:56 UT. FLT 110 mm refractor telescope, QHY5III462C camera.*

Recent Topographic Studies

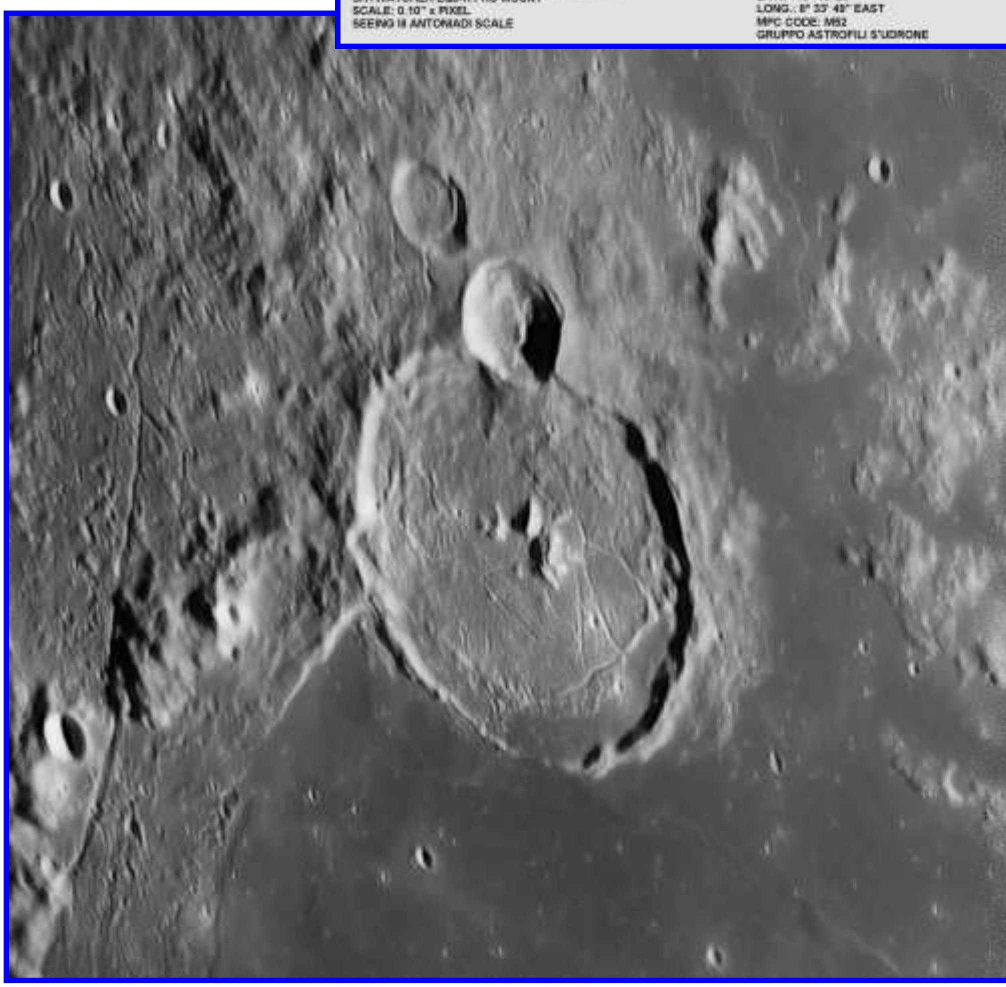


Reinhold, *Massimo Dionisi, Sassari, Italy. 2023 October 08 02:05 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X-cel LX Barlow 3x, fl 4,750 mm, IR Pass filter 685 nm, Neptune-M camera. Seeing III Antoniadi Scale.*

Aristarchus, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 26 04:49 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 4/10, transparency 5/6.*

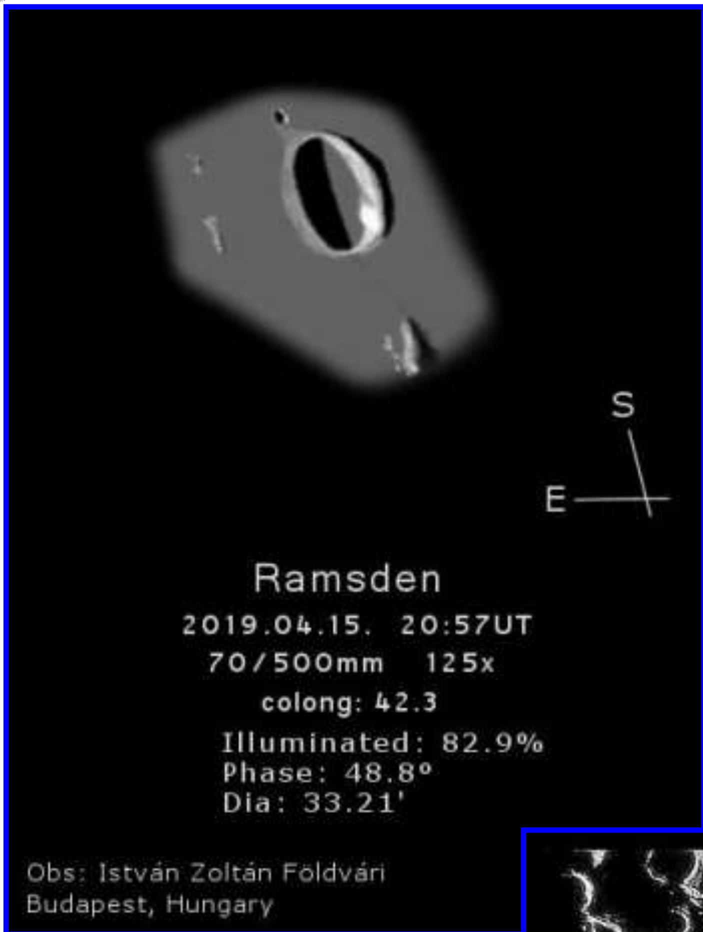
Recent Topographic Studies

Copernicus, *Massimo Dionisi, Sassari, Italy. 2023 October 08 01:55 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X-cel LX Barlow 3x, fl 4,750 mm, IR Pass filter 685 nm, Neptune-M camera. Seeing III Antoniadi Scale.*

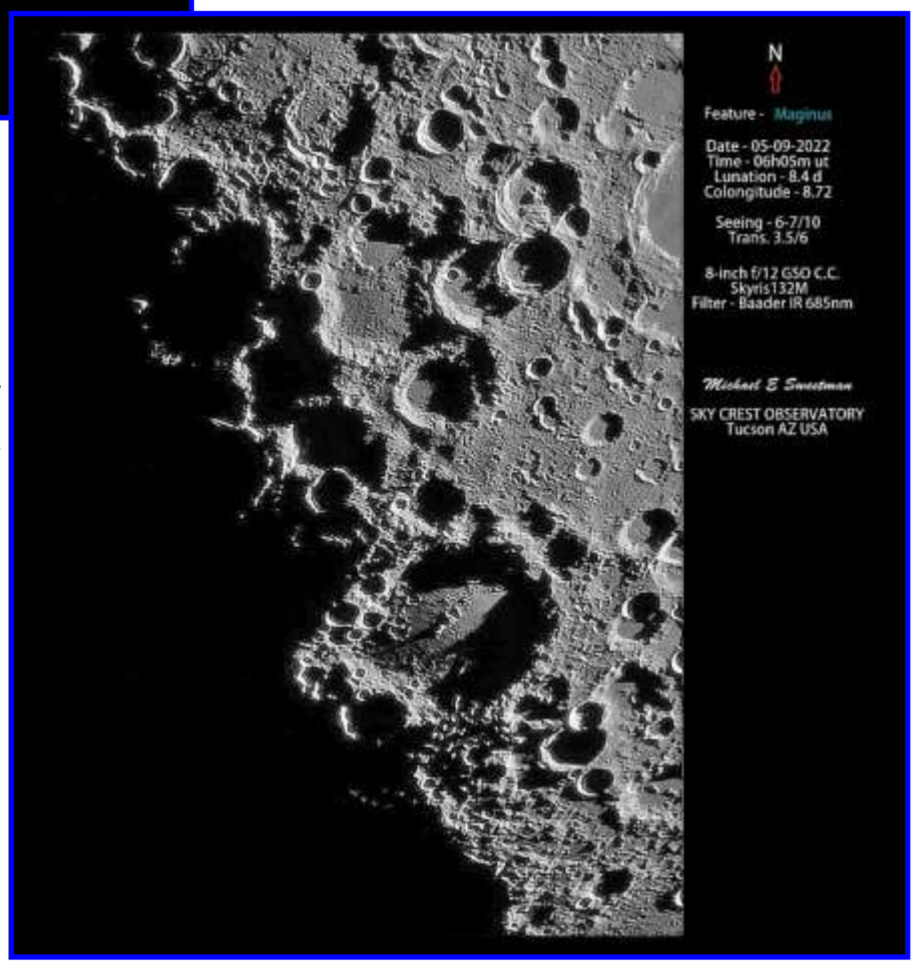


Gassendi, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 26 05:34 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 4/10, transparency 5/6.*

Recent Topographic Studies

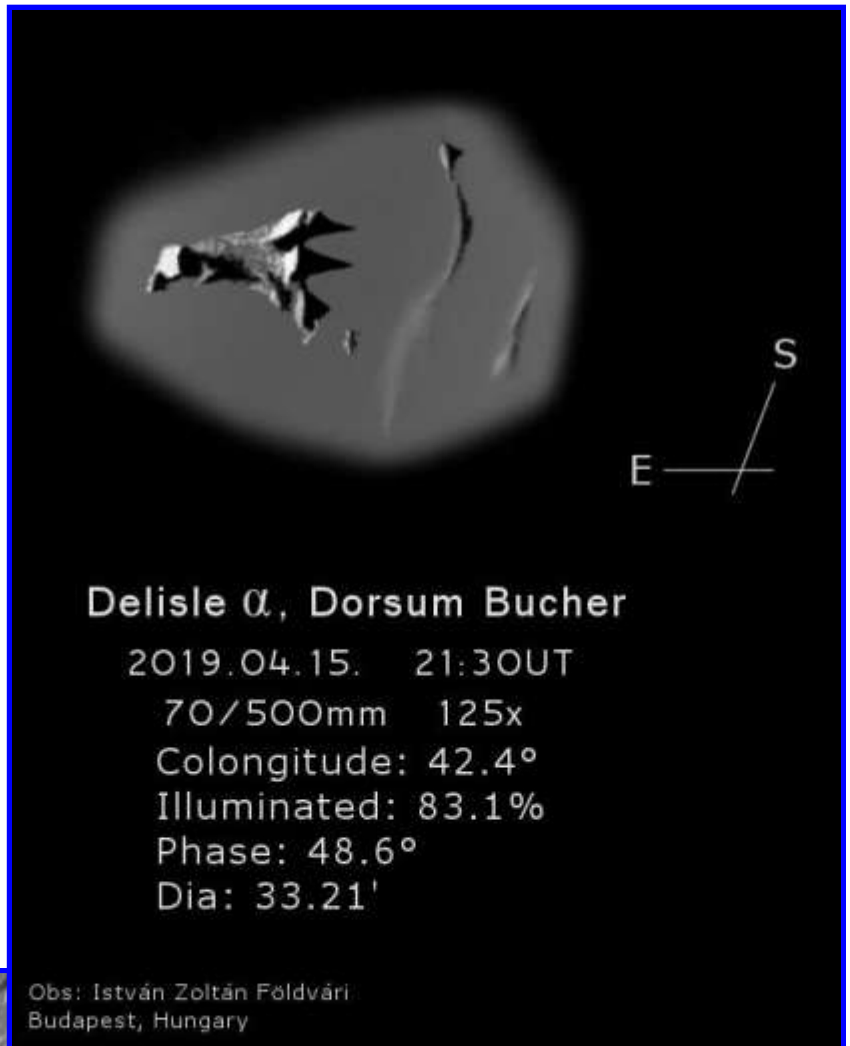


Ramsden, *István Zoltán Földvári, Budapest, Hungary. 2019 April 15 20:43-21:00 UT, colongitude 42.3º. 70 mm refractor telescope, 500 mm focal length, Vixen LV Lanthanum 4 mm, 125x. Seeing 6/10, transparency 5/6.*



Maginus, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 09 06:05 UT, colongitude 8.72º. 8 inch f/12 GSO Classical Cassegrain telescope, Baader IR 684 nm filter, Skyris 132M camera. Seeing 6-7/10, transparency 3.5/6.*

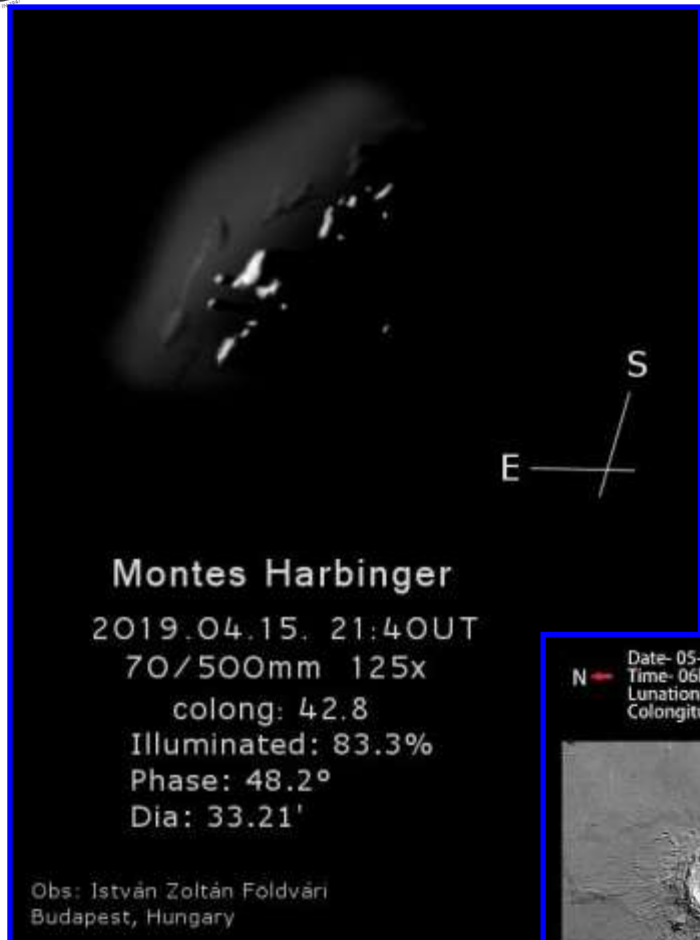
Recent Topographic Studies



Delisle α and Dorsum Bucher, *István Zoltán Földvári, Budapest, Hungary. 2019 April 15 21:12-21:37 UT, colongitude 42.4°. 70 mm refractor telescope, 500 mm focal length, Vixen LV Lanthanum 4 mm, 125x. Seeing 6/10, transparency 5/6.*

Gruithuisen, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 26 05:51 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 4/10, transparency 5/6.*

Recent Topographic Studies



Montes Harbinger and Dorsa Argand, *István Zoltán Földvári, Budapest, Hungary. 2019 April 15 21:38-22:00 UT, colongitude 42.8°. 70 mm refractor telescope, 500 mm focal length, Vixen LV Lanthanum 4 mm, 125x. Seeing 7/10, transparency 5/6.*

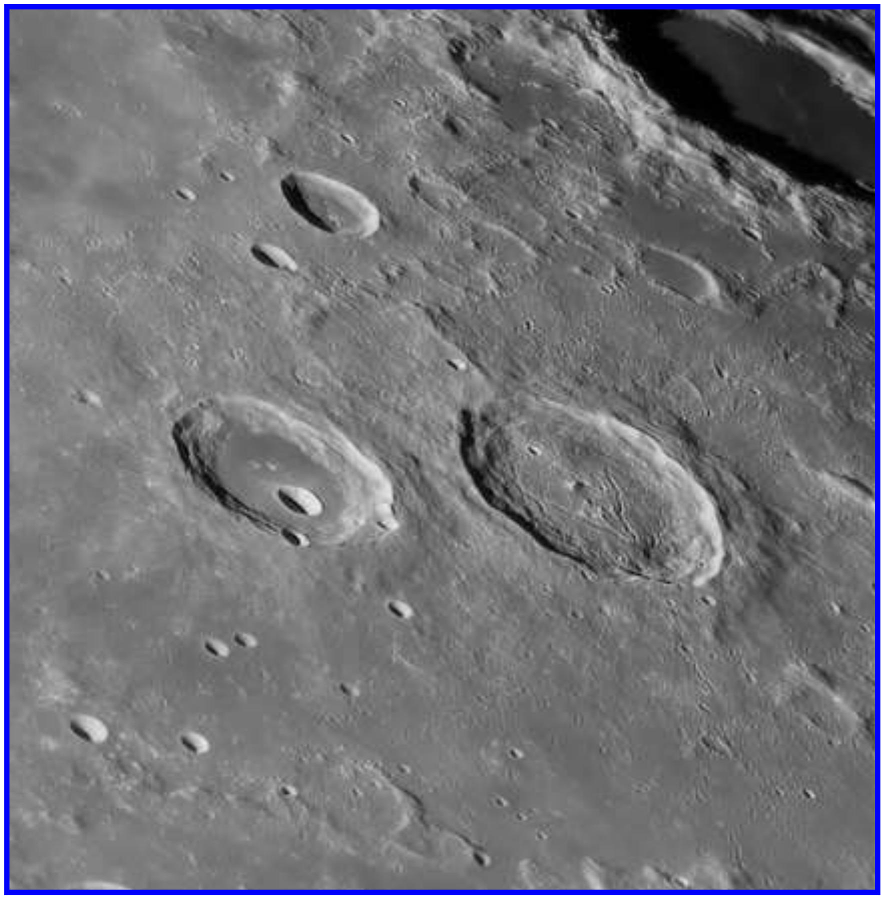
Apennine Mountains, *Michael E. Sweetman, Sky Crest Observatory, Tucson, Arizona, USA. 2022 May 09 06:19 UT, colongitude 8.84°. 8 inch f/12 GSO Classical Cassegrain telescope, Baader IR 684 nm filter, Skyris 132M camera. Seeing 6-7/10, transparency 3.5/6.*

Recent Topographic Studies

Mare Humorum, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 26 05:20 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 4/10, transparency 5/6.*

Partial Lunar Eclipse, *Dr. Matthias Brauchle, Albstadt, Germany. 2023 October 28 20:04 UT. Olympus OM1 with 1,400 mm telephoto lens.*

Recent Topographic Studies



Atlas and Hercules, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 06:47 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

Waxing Gibbous Moon, *Kim Hay. Yarker, Ontario, Canada. 2023 November 21 00:47 UT. Celestron 80 mm apochromatic refractor telescope, ZWO ASI174MM camera.*

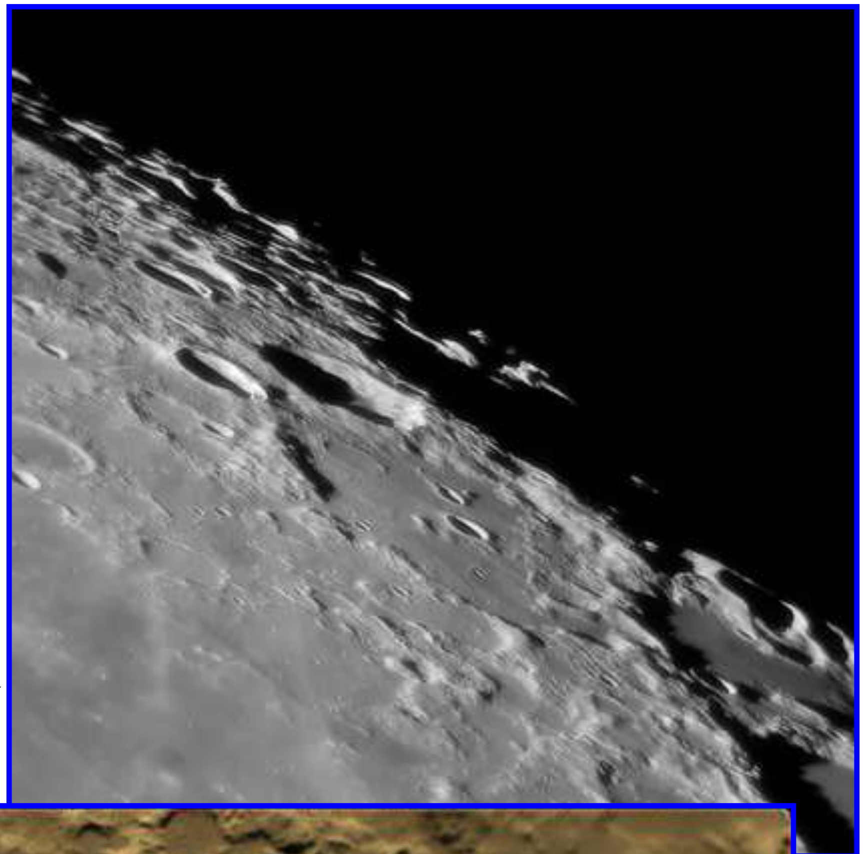
Recent Topographic Studies

Cleomedes, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 06:53 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

Altai Scarp, *Raúl Roberto Podestá, Formosa, Argentina. 2023 October 21 23:16 UT. 127 mm Maksutov-Cassegrain telescope, UV/IR cut filter and Blue #80 filter, ZWO ASI178MC camera. North is to the right, west is down.*

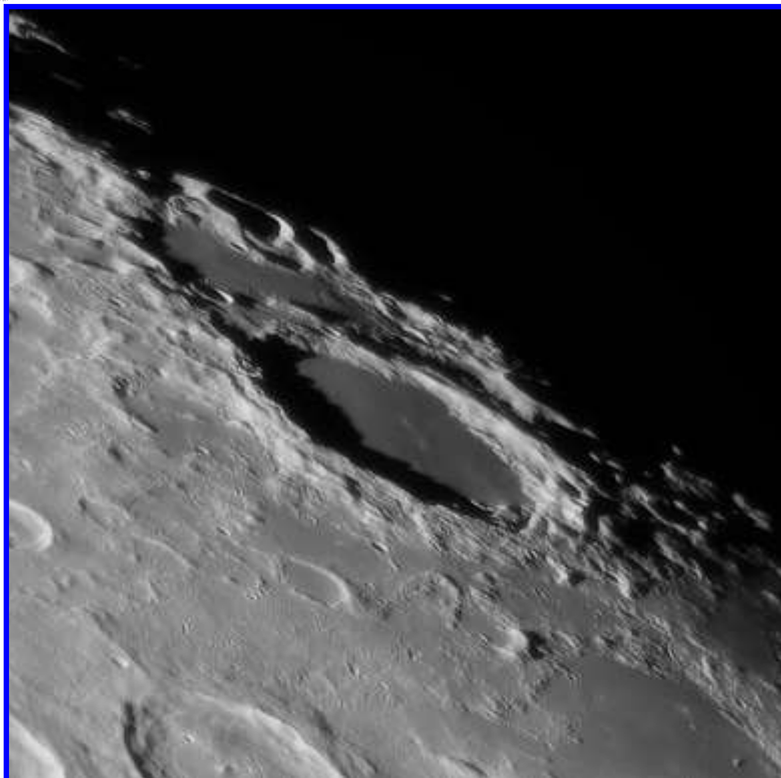
Recent Topographic Studies

de la Rue, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 07:44 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*



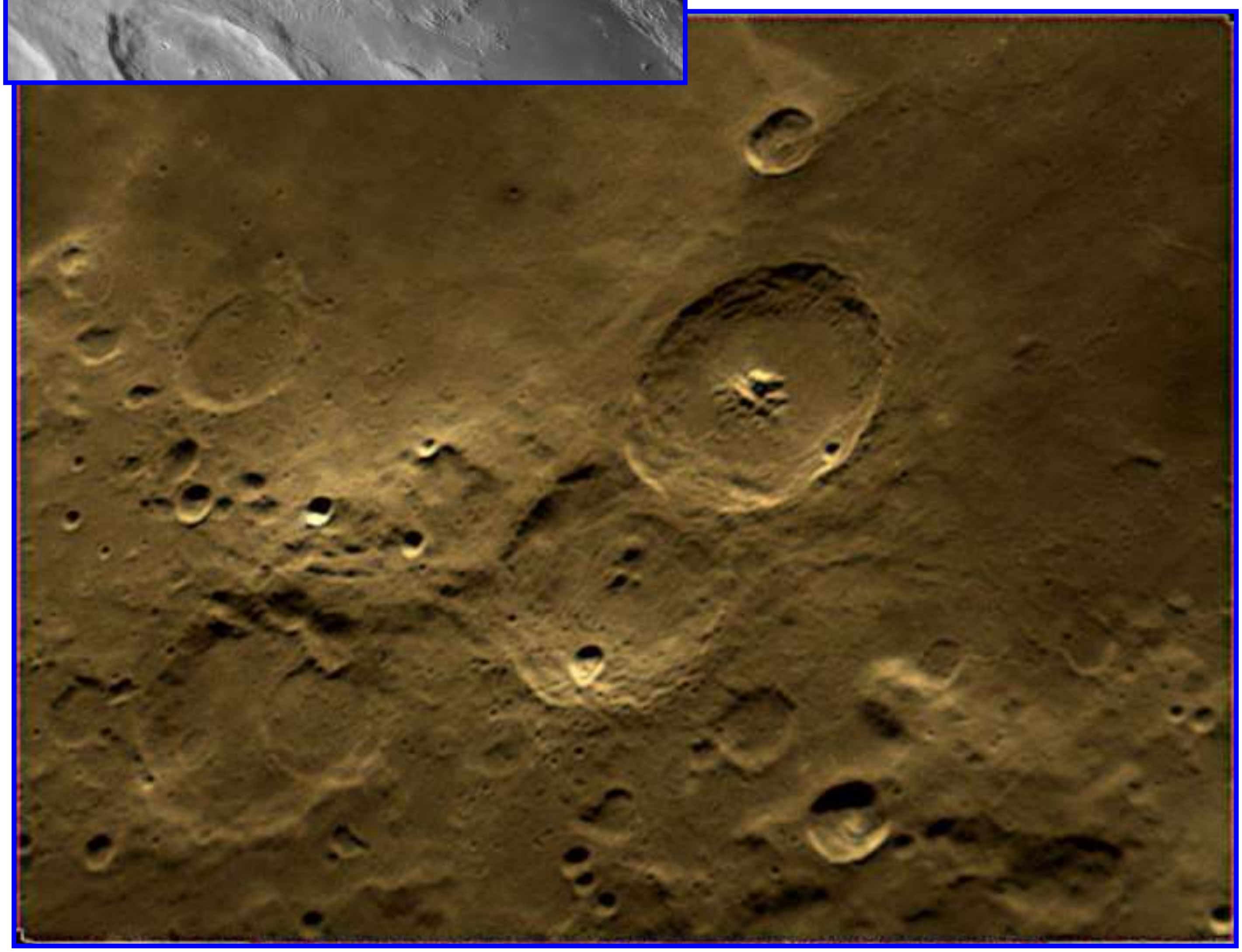
Halley, *Raúl Roberto Podestá, Formosa, Argentina. 2023 October 22 00:03 UT. 127 mm Maksutov-Cassegrain telescope, UV/IR cut filter and Blue #80 filter, ZWO ASI178MC camera. North is to the right, west is down.*

Recent Topographic Studies



Endymion, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 06:44 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

Theophilus, *Raúl Roberto Podestá, Formosa, Argentina. 2023 October 22 00:24 UT. 127 mm Maksutov-Cassegrain telescope, UV/IR cut filter and Blue #80 filter, ZWO ASI178MC camera. North is to the right, west is down.*



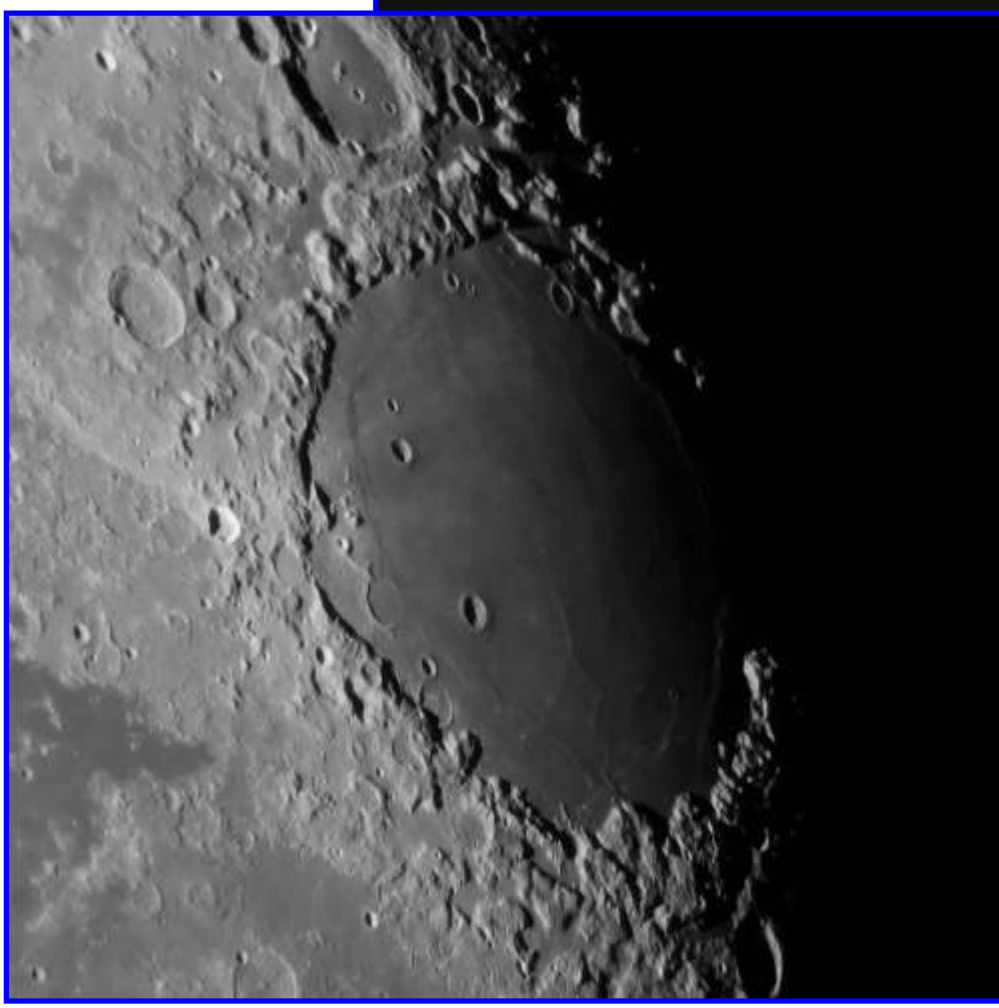
Recent Topographic Studies

Langrenus, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 07:48 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

Aristillus, *Raúl Roberto Podestá, Formosa, Argentina. 2023 October 22 00:21 UT. 127 mm Maksutov-Cassegrain telescope, UV/IR cut filter and Blue #80 filter, ZWO ASI178MC camera. North is to the right, west is down.*

Recent Topographic Studies

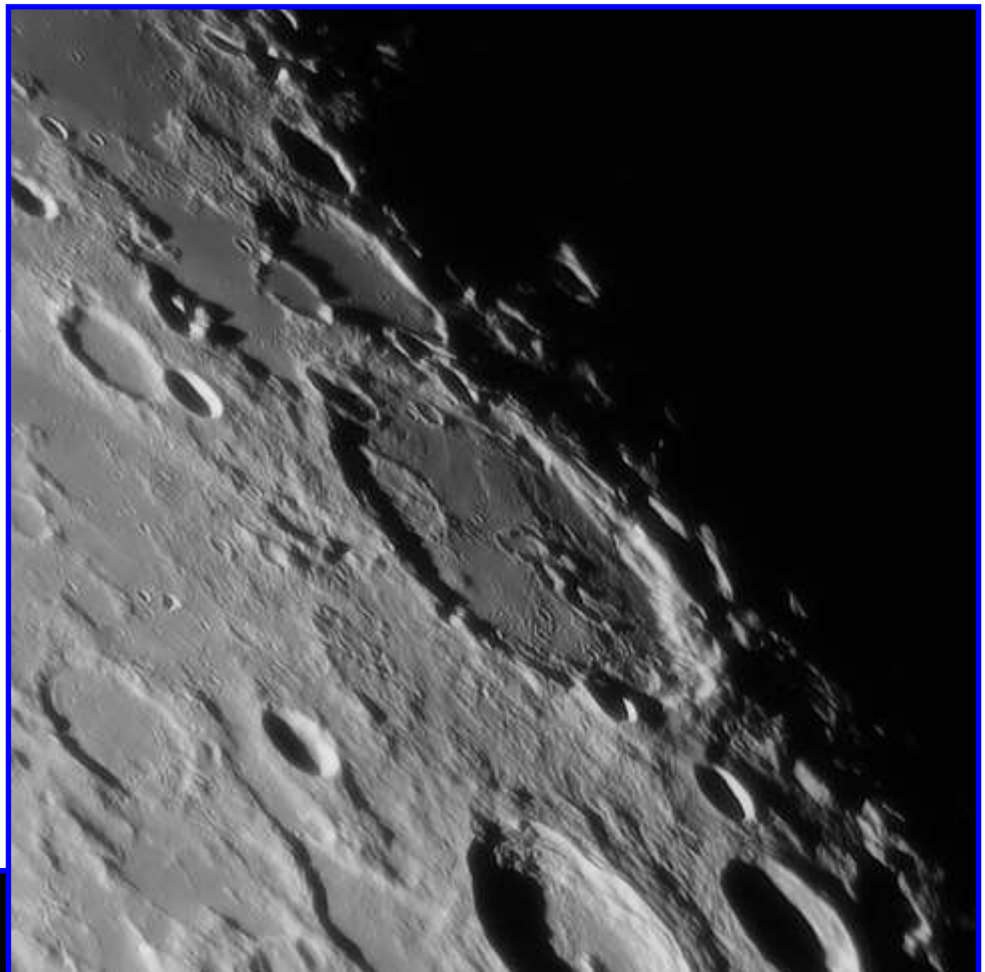
Gassendi, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 November 23 23:20 UT. Sky Watcher 150 mm reflector telescope, f/5, QHY5-II-C camera.*



Mare Crisium, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 07:02 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

Recent Topographic Studies

Messala, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 06:50 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*



Philolaus, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 November 23 23:29 UT. Sky Watcher 150 mm reflector telescope, 3x barlow, QHY5-II-C camera.*

Recent Topographic Studies

***Petavius,** Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 31 07:48 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 6/6.*

***Plato,** Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 November 23 23:32 UT. Sky Watcher 150 mm reflector telescope, 3x barlow, QHY5-II-C camera.*

Recent Topographic Studies

Aristarchus, *Maurice Collins, North Palmerston, New Zealand. 2023 November 26 09:56 UT. FLT 110 mm refractor telescope, QHY5III462C camera.*

Torricelli B, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 November 23 23:27 UT. Sky Watcher 150 mm reflector telescope, 3x barlow, QHY5-II-C camera.*

Recent Topographic Studies

Gassendi, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 November 23 23:23 UT. Sky Watcher 150 mm reflector telescope, 3x barlow, QHY5-II-C camera.*

13-day old Moon, *Maurice Collins, North Palmerston, New Zealand. 2023 November 26 09:52-09:55 UT. FLT 110 mm refractor telescope, QHY5III462C camera. North is down, west is right.*

Recent Topographic Studies

Lunar Geologic Change Detection Program

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

2023 December

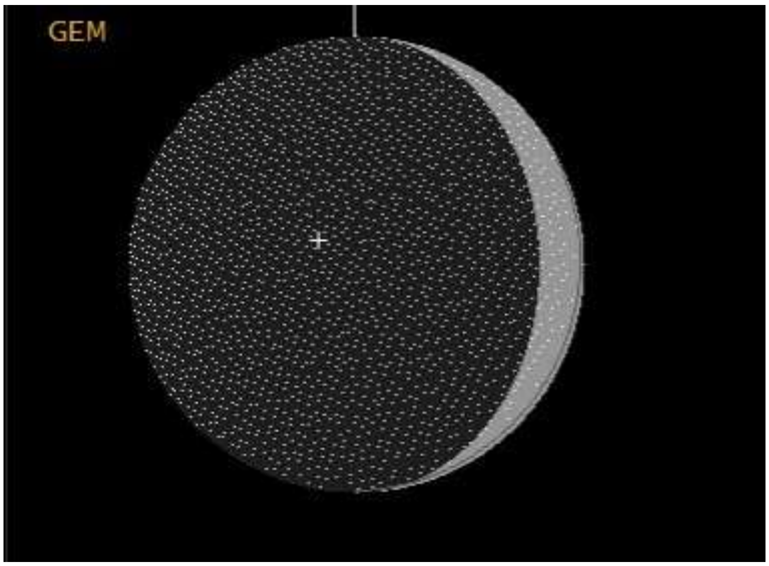


Figure 1. *A lunarscan display of the predicted impact distribution of Geminid meteoroids on the Moon at 17:00UT on 2023 December 15.*

News: Please keep a look out for Geminid meteors impacting the earthshine part of the Moon on 2023 Dec 15. Note the Moon will be at a favorably small phase of just 10% (See Fig 1), so there will little or no glare from the dayside of the Moon. Unfortunately, from northern latitudes it will be rather low down in the sky. As a rule, I usually start observing 10 min after civil twilight ends as that is usually when earthshine becomes visible. Its best to use a camera running at least 10 frames per sec and ideally 20-30 or faster. You can use software such as ALFI or FDS to search for the short < 0.1 sec impact flashes, after, and in the case of FDS, recording the video. Try to keep sunlit peaks out of the field of view if possible. Please let me (and Brian Cudnik) know what you detect, and at least tell us the start and end UTs of your observing run, even if you find no flashes. Try also to video some stars near the Moon, especially occultations, as these are useful to calibrate any impact flashes against.
LTP Reports: No LTP or impact flash reports were received for October.

Routine reports received for October included: Alberto Anunziato (Argentina – SLA) observed: Proclus and Ptolemaeus. Glenn Bates (Milton Keynes, UK - BAA) imaged the lunar eclipse. Robert Bowen (Mid Wales, UK) imaged the lunar eclipse. Maurice Collins (New Zealand - ALPO/BAA/RASNZ) imaged: Alphonsus, Archimedes, Aristoteles, Clavius, Copernicus, Eratosthenes, Plato, Rima Hadley, Tycho, and several features. Anthony Cook (Newtown, UK – ALPO/BAA/NAS) imaged: the lunar eclipse. Walter Elias (Argentina – AEA) imaged: Aristarchus. Gee Gopinath (Cardiff, UK – Aberystwyth University) imaged the lunar eclipse. Massimo Giuntoli (Italy – BAA) observed: the lunar eclipse. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Lacus Mortis and Posidonius. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Herodotus, Mare Frigoris, and Plato. Alex Vincent (UK – BAA): imaged the lunar eclipse. Ivan Walton (UK - BAA) imaged remotely, using a telescope on the Canary Islands: Copernicus.

Analysis of Reports Received (October): Again, it seems that most people have been affected badly by weather this month. Also, my apologies for the brevity of this report, but academic work has taken its toll on my available time for the write up.

Aristarchus: On 2023 Oct 01 UT 03:52 and 04:42 Walter Elias (AEA) imaged this crater under similar illumination to the following report:

On 1988 Aug 28 at UT22:00 P.Moore (Selsey, UK, 5" refractor, x260) detected a red glow along the outer west rim and 99% sure it was not a LTP as there had been a fire nearby so was probably atmospheric. However color if present, is normally seen on the south rim. The Cameron 2006 catalog ID=336 and the weight=1. ALPO/BAA weight=1.

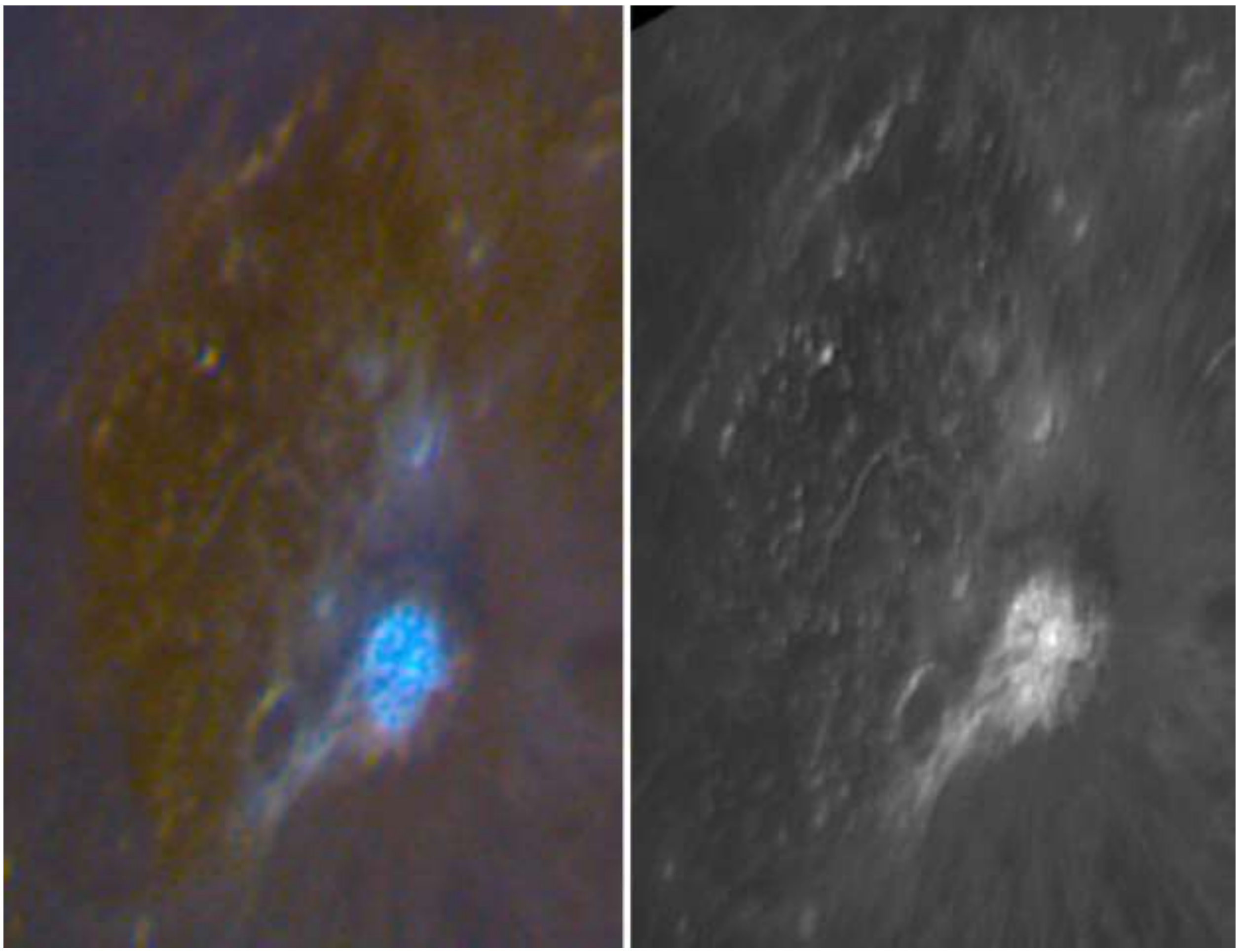


Figure 2. *Aristarchus as imaged by Walter Elias (AEA) and orientated with north towards the top.* ***(Left)*** *A color image taken at 03:52 UT with color saturation enhanced significantly.* ***(Right)*** *A monochrome infrared filter image taken at 04:42UT.*

If natural surface color was present it would certainly have shown up in the color saturation enhanced image (Fig 2 Left). There is no red color on the outer west rim, only some orange on the SE-SW ejecta blanket exterior to the crater. You can see that the crater has an unmistakable blue cast to it and the large orange-brown highland plateau area is to the west and north or the crater. with its usual trapezoidal shape. As Patrick Moore was fairly certain that he had seen an atmospheric effect, and he was using a refractor which can suffer from chromatic aberration, I think we should remove this from the ALPO/BAA LTP database by assigning a weight of 0.

Ptolemaeus: On 2023 Oct 21 UT 23:30-23:50 Alberto Anunziato observed this crater under similar illumination and topocentric libration to the following report:

Ptolemaeus 2020 Feb 01 UT 19:40-19:50 P. Sheperdson (York, UK, 102mm Mak - BAA) saw an "ashen" sliver of bright light across the floor. Images taken. This maybe normal appearance - though observer re-observed in May and found the effect different in that there was no "ashen" like effect. Visual sketches and time lapse image sequences welcome. If doing visual work – try using a polaroid filter and rotate it to see if that makes any difference. For imaging work, please over-expose slightly to bring out detail on the floor; you could also try color imaging of the floor as an interesting experiment - though for comparison purposes image other terminator features exhibiting shadow spires. ALPO/BAA weight=1.

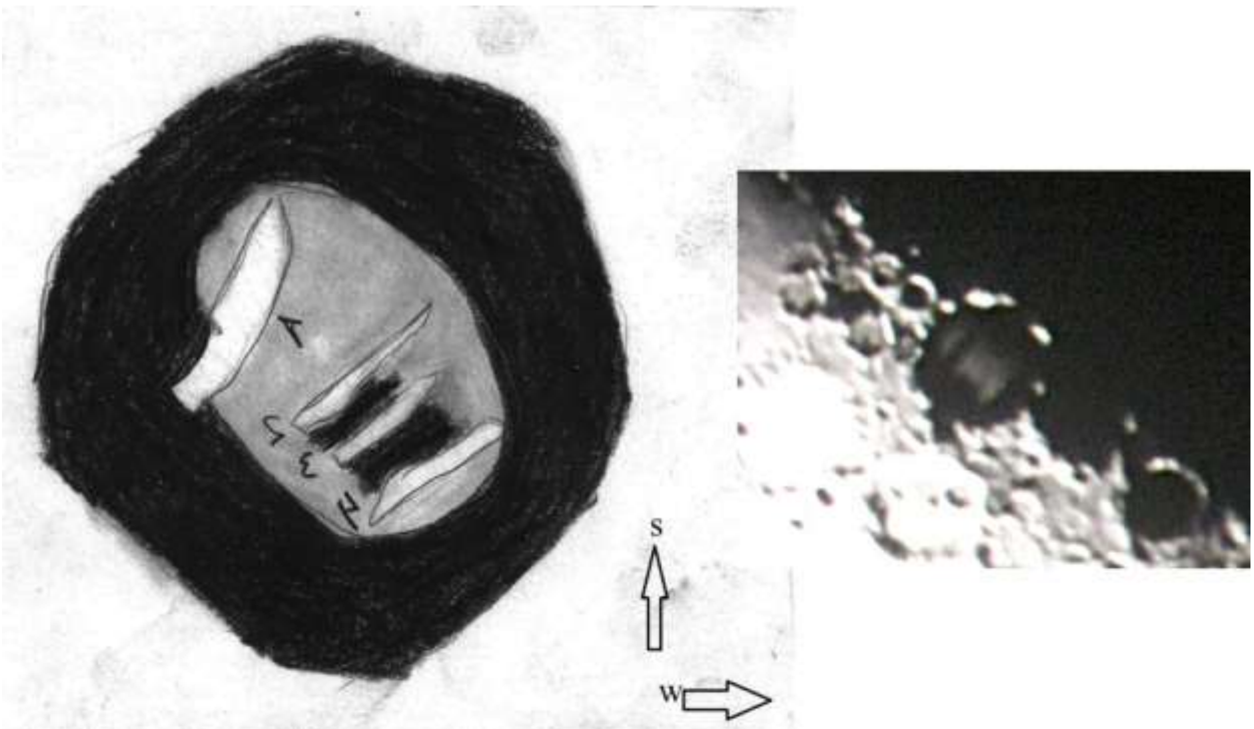


Figure 3. *Ptolemaeus with arrow directions as indicated.* ***(Left)*** *A sketch of the floor of the crater by Alberto Anunziato (SLA) made on 2023 Oct 21 UT 23:30-23:50. – numbers are mirror reversed.* ***(Right)*** *A contrast enhanced image of a frame grab from a video made on 2020 Feb 01 after Phil Sheperdson's visual observational report.*

Alberto commented…..

UT 23:30-23:50 – *"The centre of the shadow in Ptolemaeus has a lighter, gray area, in which 4 stripes of a very dull brightness appear. They look like elevations, which we know do not exist in the centre of the crater, as between the stripes 2 and 3 and 4 the shadow is black (of tone similar to the shadow of the contour), as if the stripes projected those shadows. The brightness of the stripes is from more to less: 1-3-4-2."*

UT 00:03-00:08 – *"The gray area has extended, the white stripes have a little duller brightness. There is no longer shadow between stripes 2 and 3, although it is maintained between stripes 3 and 4."*

I think Alberto's sketch (Fig 3) is very informative of the locations of the shadow spires and gaps, though does not address the "ashen sliver of bright light across the floor" that Phil Sheperdson saw. Anyway we will keep an eye on this crater at sunrise and sunset in future, and encourage both visual and time lapse imaging,

Proclus: On 2023 Oct 23 UT 07:31-07:35 Maurice Collins (ALPO/BAA/RASNZ) imaged the whole Moon under similar illumination to the following report:

Proclus 1967 Apr 18 UT 18:40-18:45 Observed by Farrant (Cambridge, England, 8" reflector x175) "Crater appeared quite dark, even bright ring was subdued & seemed thicker than normal. Drawing." NASA catalog weight=3. NASA catalog ID #1028. ALPO/BAA weight=1.

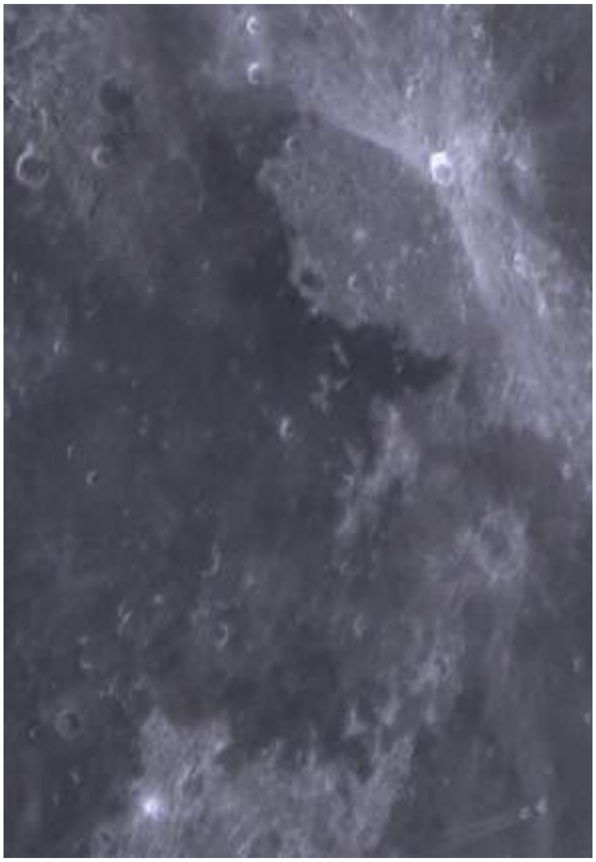


Figure 4 *Mare Tranquillitatis on 2023 Oct 23 UT 07:31-07:35 as imaged my Maurice Collins with north towards the top.*

Contrary to what Farrant saw, Proclus actually looks quite bright in Fig 4. I think we shall leave the weight at 1 for now. Perhaps it's a libration issue which might have made the slopes on the illuminated walls less bright and less distinct back in 1967? Future observations at a similar libration could help solve this.

Jansen E: On 2023 Oct 04 UT 07:33 Rik Hill (ALPO/BAA) imaged Posidonius and Mare Serenitatis, but on the bottom edge of his image was Jansen E under similar illumination to the following lunar schedule request:

BAA Request: On 2013 Aug 26 Peter Grego observed a dark patch just east of Jansen E. He had not seen this before; therefore it is important to repeat this observation under similar illumination conditions. It may be a buried crater? Ideally suited to scopes of aperture 8" or larger. Please send any high resolution images, detailed sketches, or visual descriptions to: a t c @ a b e r . a c. u k .

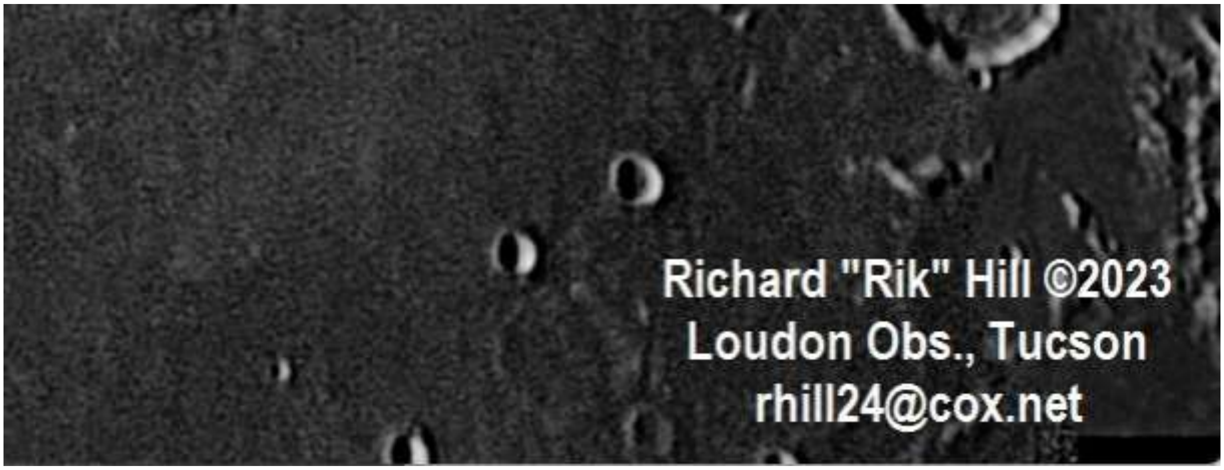


Figure 5. *2023 Oct 04 UT 07:33 An enlargement of the original image by Rik Hill with north towards he top. Jansen E is the crater on the bottom edge about 1/3rd of the way from the left to the right.*

Examining Fig 5 reveals just a sharp rim black shadow on the east of Jansen E, and no dusky dark area extending further to the east that was reported by Peter Grego back in 2013. We have covered this report before in the 2013 Oct and 2018 Oct newsletters, and will leave the LTP weight of 1 as it is for now.

Herodotus: On 2023 Oct 26 UT 20:55-21:20 Trevor Smith (BAA) Observed visually this crater under similar illumination to the following report:

On 1965 Jun 12 at UT > 00:00 an unknown observer (Porta?) reported that the area of Herodotus and the Cobra Head expanded and the color went to rose. The next night the floor was normal. In filters, phenomenon accentuated in orange. The Cameron 1978 catalog ID=880 and weight=3. The ALPO/BAA weight=2.

Trevor noticed that the crater had a slight, albeit noticeable pink/orange hue on the western floor and the interior of the western rim. He thinks this was probably related to atmospheric conditions, but at the same time could not see similar examples of color elsewhere in that part of the Moon? Trevor was using a 16" Newtonian under Antoniadi IV seeing conditions. We shall keep the ALPO/BAA weight of the 19675 report at 2 for now.

2023 Oct 28 - Partial Lunar Eclipse: Weather conditions were a challenge to most of our observers. I and Massimo Giuntoli, were struck by how dark the umbral shadow looked visually. Massimo observed with 10x50 binoculars from 20:30-20:37 UT and mentions that the color of the umbra was a dark grey, no reddish hue seen, and the edge of the umbra was definitely no sharp. Massimo said that the interior of the eclipsed portion of the Moon was not visible to the eye. Although I attempted to image with a zoom setting on my Samsung Galaxy S20 Pro smart phone, the results were anything but intelligent, making the Moon look like early pre-telescopic era sketches of the Moon, resembling a Man in the Moon. I attempted to set up my 8-inch Newtonian, equipped with initially a long wave thermal UR camera operating at 7.5-14 microns. The umbra showed up a as very slightly darker (cooler) area of the Moon, but was not as dark (cooler) as I had noticed during previous total lunar eclipses. Indeed it was very difficult to see where the umbra started and ended as it was very fuzzy. As the Full Moon is generally featureless in the thermal IR, I decided to switch to a short wave IR camera, with a filter, covering the waveband on 1.5-1.7 microns. This time, I was able to see clear detail in the umbra, resembling bright earthshine views. The contrast between the shadow and the dayside of the Moon in this waveband was not so different. Unfortunately before I could do a calibration, and hit the record button, the gaps between the clouds, vanished and that was the end of the eclipse for me! Alex Vincent sent in some images that were significantly better than my efforts, but they too were thwarted by cloud. However the best results I have seen so far came from Glenn Bates (Fig 6 – Left) and Robert Bowen (Fig 6 – Right).

Figure 6. *The partial eclipse of the Moon taken on 2023 Oct 28.* ***(Left)*** *by Robert Bowen at 20:43UT from Cyprus.* ***(Right)*** *by Glenn Bates at 22:01UT, from Milton Keynes.*

Why are we interested in lunar eclipse from the lunar geological change point of view? Because many LTP have been seen during lunar eclipses, and the surface undergoes wild short term temperature swings which put thermal stresses on rocks which are expanding and contracting then expanding again. Also the darkness and color of the eclipse tells us about some of the properties of the Earth's upper atmosphere. Information can be gleaned, not only from the umbral region, but the much fainter penumbra.

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. 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

Basin and Buried Crater Project

Coordinator Dr. Anthony Cook- atc@aber.ac.uk

During the last month, no images, or sketches, have been sent in specifically for the BBC project. Also as my academic work has taken its toll on my free time in the last few weeks, I have not been able to pick a random suspected buried crater or basin, from this list, in order to check it out and write it up in our monthly report.

Please do think about imaging some of the candidate basins and buried craters listed on the web link: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm , over the next month and email them to me. Or alternatively investigate evidence for them on the NASA Quickmap website: https://quickmap.lroc.asu.edu/ - at least that approach does not depend upon the weather.

Lunar Calendar December 2023

Date	UT	Event
1	0400	Pollux 1.6^o N of the Moon
1		South limb most exposed (-6.7^o)
4	1900	Moon at apogee 404,346 km
5	0549	Last Quarter Moon
8	1524	Moon at descending node
9	1700	Venus 4^o N of Moon
11		West limb most exposed (-5.6^o)
12	2332	New Moon lunation 1249
14		Greatest southern declination (-28.2^o)
14	0500	Mercury 4^o N of Moon
15		North limb most exposed (+6.6^o)
16	1900	Moon at perigee 367,901 km
17	2200	Saturn 2^o N of Moon
19	1300	Neptune 1.3^o N of Moon, occultation Antarctica and Australia
19	1839	First Quarter Moon
21	1354	Moon at ascending node
22	1400	Jupiter 3^o S of Moon
23	1500	Uranus 3^o S of Moon
24	0800	Moon 1.0^o S of Pleiades
25		East limb most exposed (+4.8^o)
27		Greatest northern declination (+28.1^o)
27	0033	Full Moon
28		South limb most exposed (-6.6^o)
28	1200	Pollux 1.7^o N of the Moon

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: Sinus Iridum

Focus on is a bi-monthly series of articles, which includes observations received for a specific feature or class of features. The subject for the January 2024, will be Sinus Iridum. 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

Deadline for inclusion in the Sinus Iridum Focus-On article is December 20, 2023

FUTURE FOCUS ON ARTICLES:

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

Subject	TLO Issue	Deadline
Sinus Iridum	**January 2024**	**December 20, 2023**
Lacus Mortis	**March 2024**	**February 20, 2024**
Chains of Craters	**May 2024**	**April 20, 2024**
Mare Nectaris	**July 2024**	**June 20, 2024**

Focus-On Announcement
A Dream Landscape: Sinus Iridum

Few places on the Moon are as evocative as Sinus Iridum, The Bay of the Rainbow. An ancient crater flooded by the lavas of Mare Imbrium is, at the same time, a pareidolia of a bay, and the near side itself is a pareidolia of land and sea. We have known for centuries that it is not a mountainous bay, but it continues to fascinate us as if it were the Cote d'Azur from another world. Beyond science fiction, which has chosen it several times to situate its adventures, we propose to share images to learn a little more about this dream land of contrasts.

JANUARY 2024 ISSUE-Due December 20, 2023: SINUS IRIDUM

MARCH 2024 ISSUE: Due February 20, 2024: LACUS MORTIS

FOCUS ON MAY 2024: Due April 20, 2024: CHAIN OF CRATERS

FOCUS ON JULY 2024: Due June 20, 2024: MARE NECTARIS

Larry Todd

Focus-On Announcement
Lacus Mortis: One of the Strangest-Looking Parts of the Moon

The definition belongs to the remembered Peter Grego and they are words that justify us taking a tour of this selenographic feature, difficult to define: a plain? Rather, an enormous and very old crater, of which little remains, in the center of which is a very prominent crater, Bürg, and which has been almost completely covered by lava, which adds to the charm of this very ancient crater-plain the attractions of rilles, wrinkle ridges and even the skylight of a lava tube. We are going to add images to analyze this very particular area, located at the eastern end of Mare Frigoris.

JANUARY 2024 ISSUE-Due December 20, 2023: SINUS IRIDUM

MARCH 2024 ISSUE: Due February 20, 2024: LACUS MORTIS

FOCUS ON MAY 2024: Due April 20, 2024: CHAIN OF CRATERS

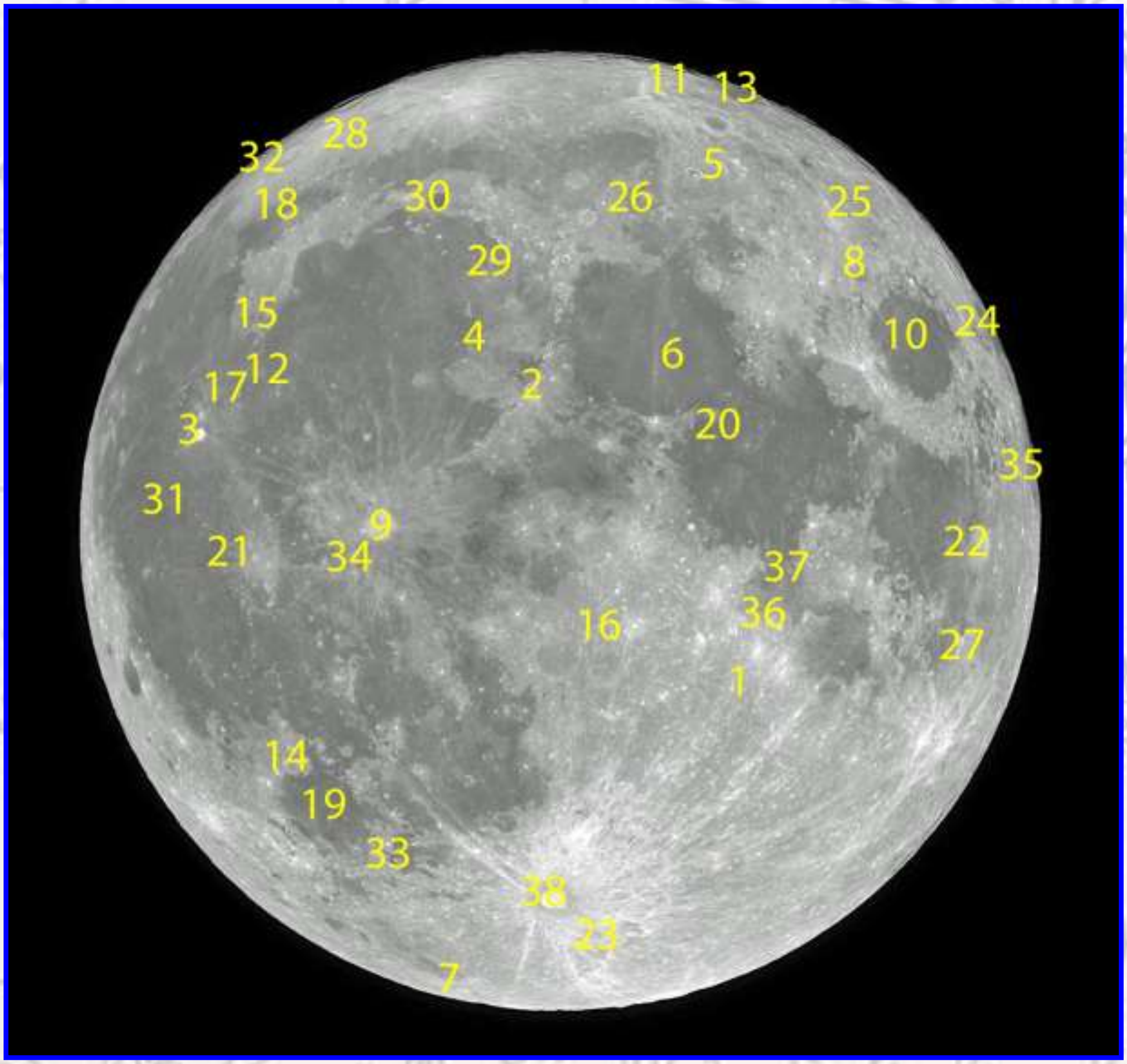
FOCUS ON JULY 2024: Due June 20, 2024: MARE NECTARIS

FOCUS ON SEPTEMBER 2024: Due August 20, 2024: ARISTOTELES AND EUDOXUS

FOCUS ON NOVEMBER 2024: Due: October 20, 2024: ARCHIMEDES, AUTOLYCUS AND ARISTILLUS

David Teske

Key to Lunar Images In This Issue



Gregory Shanos

1. Altai Scarp
2. Apennine Mountains
3. Aristarchus
4. Aristillus
5. Atlas
6. Azara, Dorsum
7. Bailly
8. Cleomedes
9. Copernicus
10. Crisium, Mare
11. de la Rue
12. Delisle
13. Endymion
14. Gassendi
15. Gruithuisen
16. Halley
17. Harbinger, Montes
18. Horrebow
19. Humorum, Mare
20. Jansen
21. Kepler
22. Langrenus
23. Maginus
24. Marginis, Mare
25. Messala
26. Mortis, Lacus
27. Petavius
28. Philolaus
29. Piazzi Smyth
30. Plato
31. Procellarum, Oceanus
32. Pythagoras
33. Ramsden
34. Reinhold
35. Smythii, Mare
36. Theophilus
37. Torricelli
38. Tycho