The Lunar Observer

A Publication of the Lunar Section of ALPO

David Teske, editor
Coordinator, Lunar Topographic Studies Section Program

November 2023

In This Issue

Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2011 September 04 02:11 UT. Celestron 14 inch Schmidt-Cassegrain telescope, 1.6x barlow, W23 filter, DMK21AU04 camera. Seeing 8/10.*

Online readers, click on images for hyperlinks

Lunar Reflections

Hoping all of out readers have had a great month. Weather-wise, it has been much relief in the northern hemisphere from a hot summer, though events of the world have been gloomy. To our southern hemisphere observers, I hope that spring has been pleasant.

On this page I include a photo of the Moon not normally seen, that of a New Moon! The annular eclipse of October 14, 2023 was visible in much of North and South America, at least partially. I was amazed watching how fast the Moon moved as it consumed sunspots! Also, it was most interesting to see obvious crater rims on the lunar limb. I was always wondering what those craters were!

I hope that you enjoy the current issue of *The Lunar Observer*. It has a number of interesting articles in it by Rik Hill, Jeff Grainger, KC Pau, Pau Walker and Alberto Anunziato as they explore lunar topography. Alberto Anunziato leads us on a fascinating tour of Dorsa Smirnov as he uses observations from across the world and lunar orbit for the latest Focus-On installment. As always, Tony Cook has his great articles about Lunar Geologic Change and Buried Basins and Craters. Please continue to contribute to his outstanding programs!

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

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The Annular Solar Eclipse from Oro Verde, Argentina. *Walter Ricardo Elias and Avril Elias, AEA. 2023 October 14 19:28 UT. 150 mm Sky Watcher reflector telescope, Canon T1i camera.*

Lunar Topographic Studies

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Observations Received

Name	Location and Organization	Image/Article
Katie Anderson	Detroit, Michigan, USA	Image of Mare Imbrium.
Alberto Anunziato	Paraná, Argentina	Drawing of Posidonius Y, Article *Focus-On: Hiking In the Moon: Dorsa Smirnov* and *article with drawing Dorsum Zirkel.*
Sergio Babino	Montevideo, Uruguay, SAO	Image of Posidonius
Jean Bourgeois	Pic du Midi observatory, Pyrénées, France	Image of Mare Serenitatis.
Francisco Alsina Cardinalli	Oro Verde, Argentina	Images of Mare Serenitatis (2).
Jairo Chavez	Popayán, Colombia	Images of Montes Apenninus, 72% Waxing Gibbous Moon and the Waning Gibbous Moon.
Maurice Collins	Palmerston North, New Zealand	Images of the 6.6-day old Moon, Tycho, Clavius, 8.6-day old Moon, Plato, Copernicus, Aristoteles, Alphonsus and the 13.6-day old Moon.
Don Capone	Waxahachie, Texas, USA	Image of Posidonius.
Jef De Wit	Hove, Belgium	Drawing of Dorsa Smirnov.
Massimo Dionisi	Sassari, Italy	Images of Copernicus, Milichius, Gruithuisen, Aristarchus, Kepler (2), Prinz, Encke, Marius (2), Rümker, Billy, Reiner, Gassendi, Cavalerius, Messala, Atlas (2), Cleomedes, Yerkes, Endymion, Messier, Taruntius, Mare Fecunditatis, Santbech, Janssen, Vitruvius, Jansen, Cauchy (2), Maraldi, Fracastorius, Sinus Amoris and Gärtner
Walter Ricardo Elias	Oro Verde, Argentina, AEA	Images of Dorsa Smirnov (2), Langrenus, Mare Crisium, Petavius (2), Pontécoolant, the Annular Solar Eclipse, Gassendi, Aristarchus (2), Archimedes, Prinz, Schickard and Sirsalis.
István Zoltán Földvári	Budapest, Hungary	Drawings of Manzinus, de Sitter and Theophilus
Jeff Grainger	Cumbria, UK	Article *Mare Crisium: A Review of Major Features* and an image of Dorsa Smirnov.
Anthony Harding	Northeast Indiana, USA	Images of Dorsa Smirnov (4)

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

Lunar Topographic Studies

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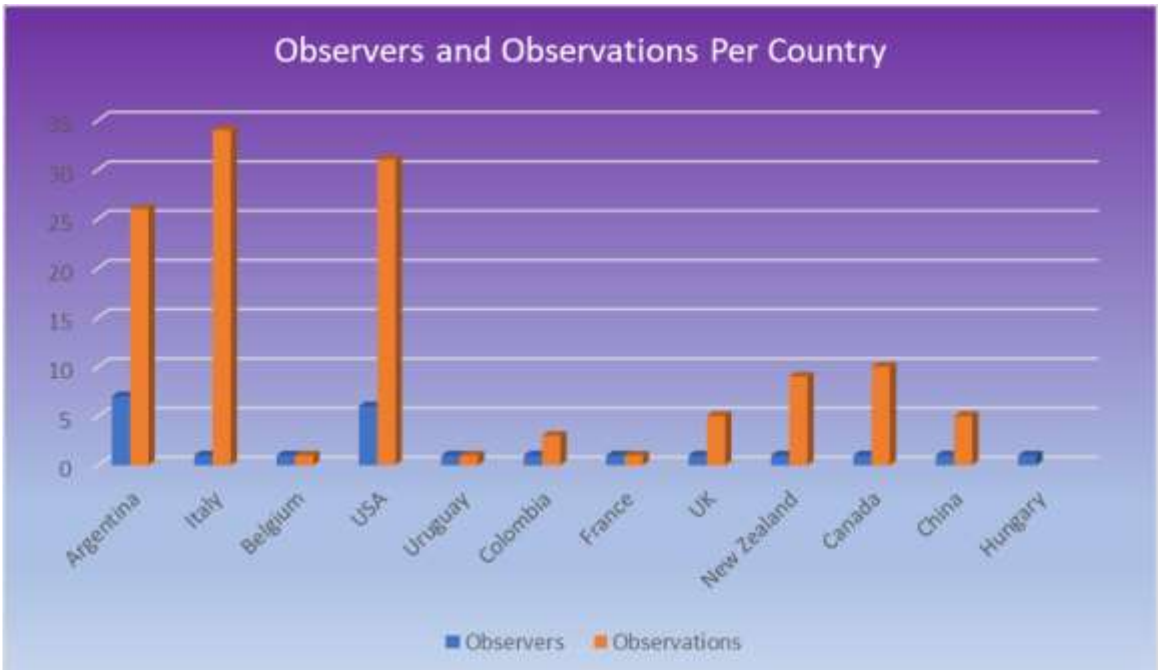
Observations Received

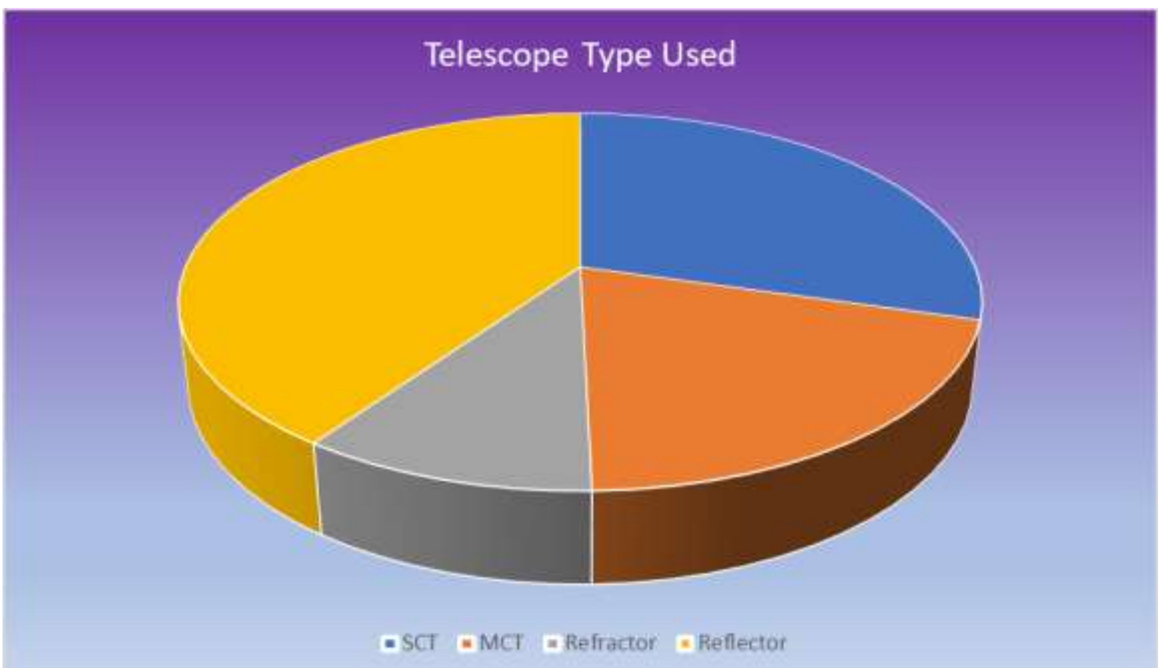
Name	Location and Organization	Image/Article
Rik Hill	Loudon Observatory, Tucson, Arizona, USA	Article and image *Kepler to Marius, Wrinkles*, images of Posidonius (6).
Eduardo Horacek	Mar del Plata, Argentina	Images of Dorsa Smirnov (2).
Gabriel Kloster	Oro Verde, Argentina, AEA	Image of Langrenus.
Ron May	El Dorado Hills, California, USA	Images of the Lunar V and X.
KC Pau	Hong Kong, China	Article *Eyes of Clavius*.
Fernando Sura	San Nicolás de los Arroyos, Argentina	Image of Petavius.
David Teske	Louisville, Mississippi, USA	Images of Mare Serenitatis (11).
Kenny Vaughn	Cattle Point, Victoria, British Columbia, Canada	Images of Copernicus, Deslandres, Eastern Mare Imbrium, Eratosthenes, Plato, Ptolemaeus, Rupes Recta, Three A's, Tycho and Clavius.
Gonzalo Vega	Oro Verde, Argentina, AEA	Images of Copernicus, Hahn and Mare Crisium.
Paul Walker	Middlebury, Vermon, USA	Article and images *Dorsa Smirnov and Eastern Mare Serenitatis and A Good Moring of Imag-*

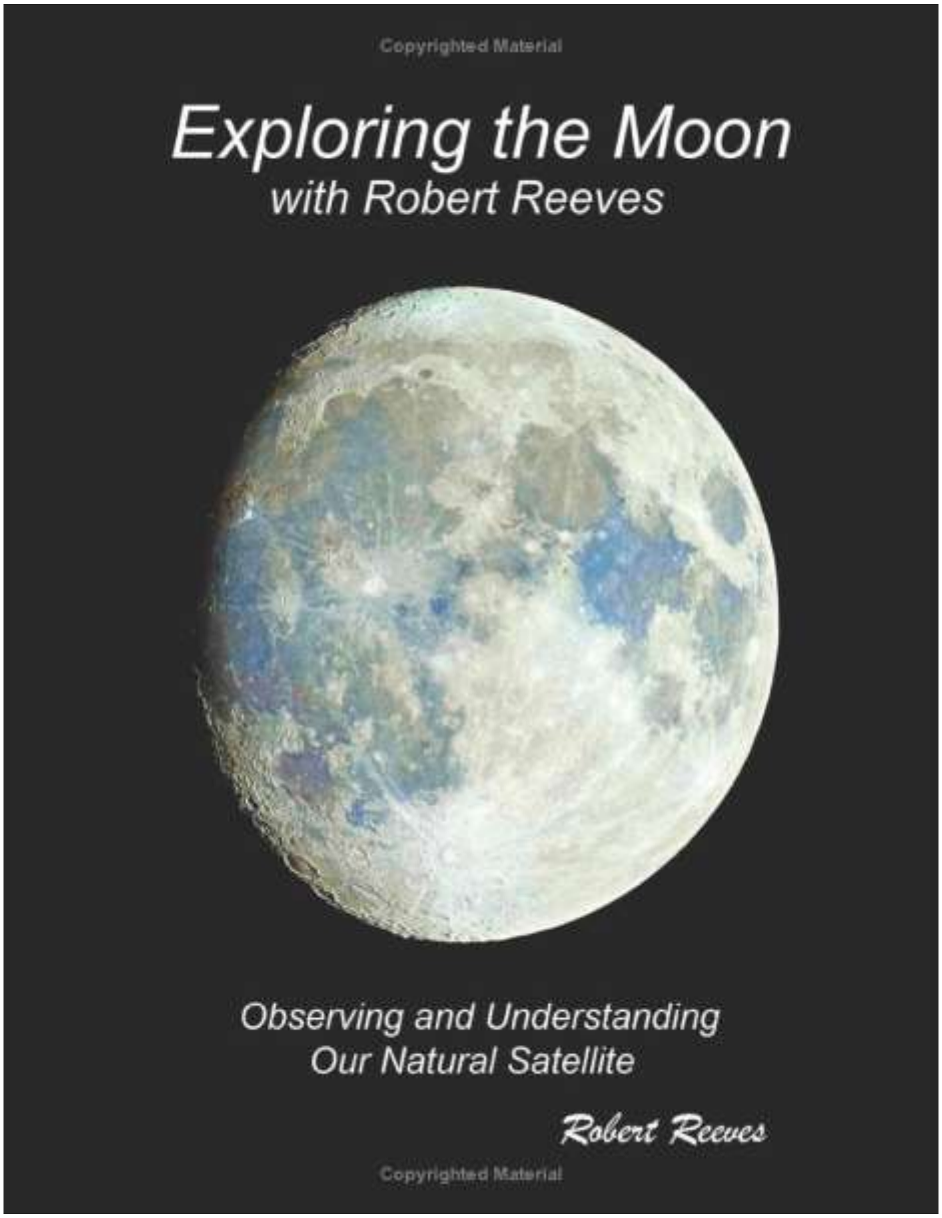
Many thanks for all these observations, images, and drawings.

November 2023 *The Lunar Observer* By the Numbers

This month there were 129 observations by 23 contributors in 12 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

The Lunar V (above) and Lunar X (below), *Ron May, El Dorado Hills, California, USA. 2023 September 22 04:17 UT. 3.5 inch Questar Maksutov-Cassegrain telescope, iPhone 12 camera. With and without arrow.*

Recent Topographic Studies Lunar V and Lunar X

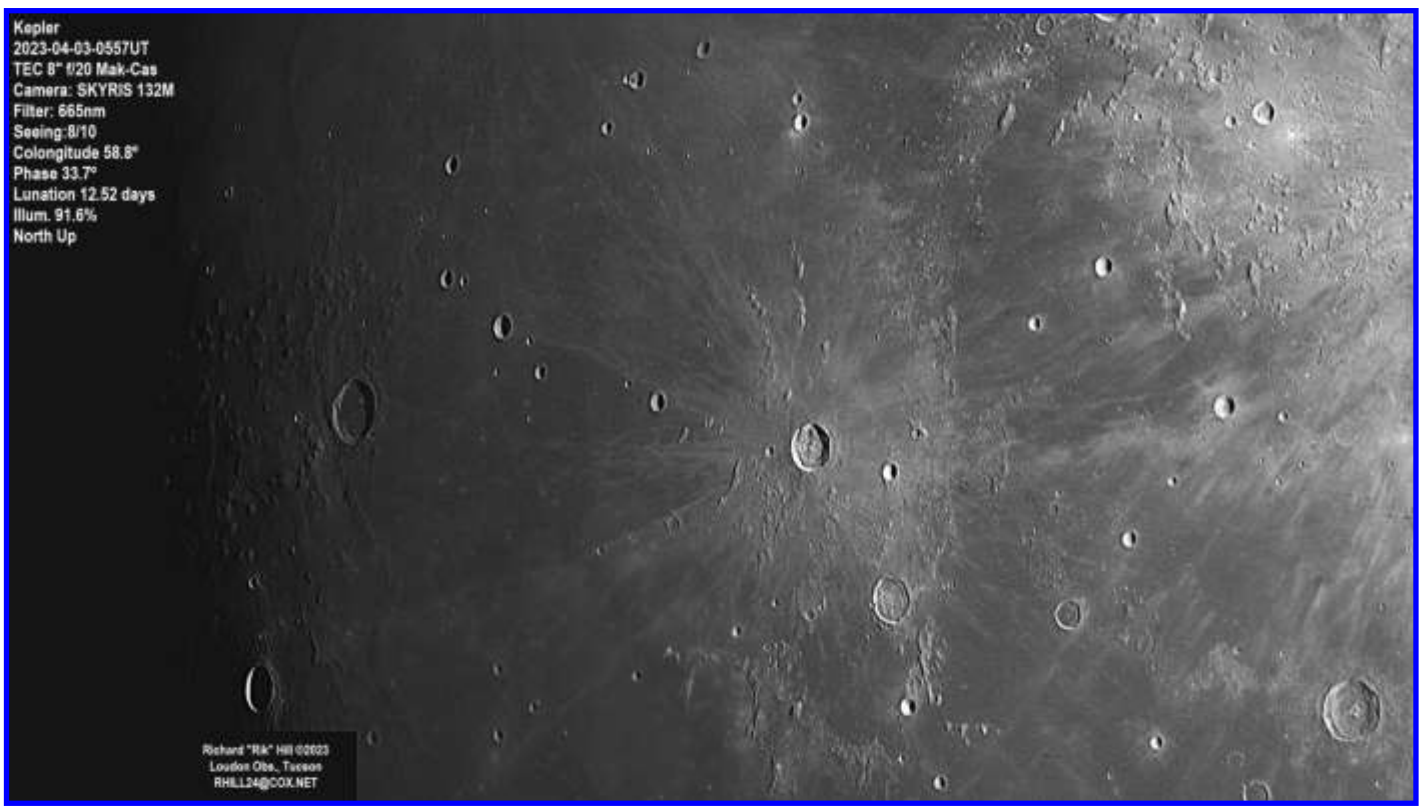
Kepler to Marius

Rik Hill

Situated on the east side of the sprawling Oceanus Procellarum is the great crater Kepler (32 km dia.) almost lost in splendor to its bigger brother further to the east, Copernicus, three times bigger with a much larger ray system surrounding it. Between these two is Mare Insularum a very isolated sea. There is much to be gleaned from the wonderful ray system of Kepler and surrounding features. First, notice the lack of symmetry to the Keplerian ray system, strongly attenuated on the right in line with the mountains that run roughly north-south there. I have never read anything on why this is so. Meanwhile, on the left side of Kepler notice the strong "V" shape to the rays with fainter rays in the center of the "V" that point towards the flat floored crater Marius (40 km). Interestingly, these central rays are quite feathered. In these central rays is the spot where Luna 7 lies. It was launched October 4, 1965 and due to improper rocket firing and then shutdown it suffered what Virtual Moon Atlas calls an "involuntary impact" (i.e., crash).

Below Kepler is the almost same diameter and older crater Encke (31 km). It's a somewhat polygonal crater infilled with ejecta from the Kepler impact making it a lighter color than the surrounding mare. In the lower right corner is Lansberg (41 km). To the right of Kepler is a large right triangle of 8-14 km diameter craters with Milichius (12 km) at the vertex of the right angle and Hortensius (14 km) on the lower vertex and Milichius A (8 km) being the one closest to Kepler. The first two craters are hosts to other dome features, Dome Milichius and Hortensius Omega, which are not well shown here due to high sun at their longitudes but should be sought out when near the terminator.

Mentioned above, the flat floored crater Marius (40 km) is on the left (west) side of this image. It is surrounded by a pox field called Domes Marius or colloquially, the Marius Hills. These are small upwellings and volcanic domes with central pits on many that can by spied by sharp eyed observers with sufficient aperture and magnification. The altitudes of these hills are only about 200-500 m with sinuous rimae winding between some of them and in one case southeast of Marius itself, several rimae cut right through the hills. The low altitudes mean that like the Hortensius and Milichius domes above, they have to be on the terminator to be seen clearly and vanish entirely in high sun. This is a rich and rewarding area for the lunar observer, worthy of good scrutiny by the northern hemisphere observers on the bright moon nights of fall and winter when this gibbous phase is high in the sky.



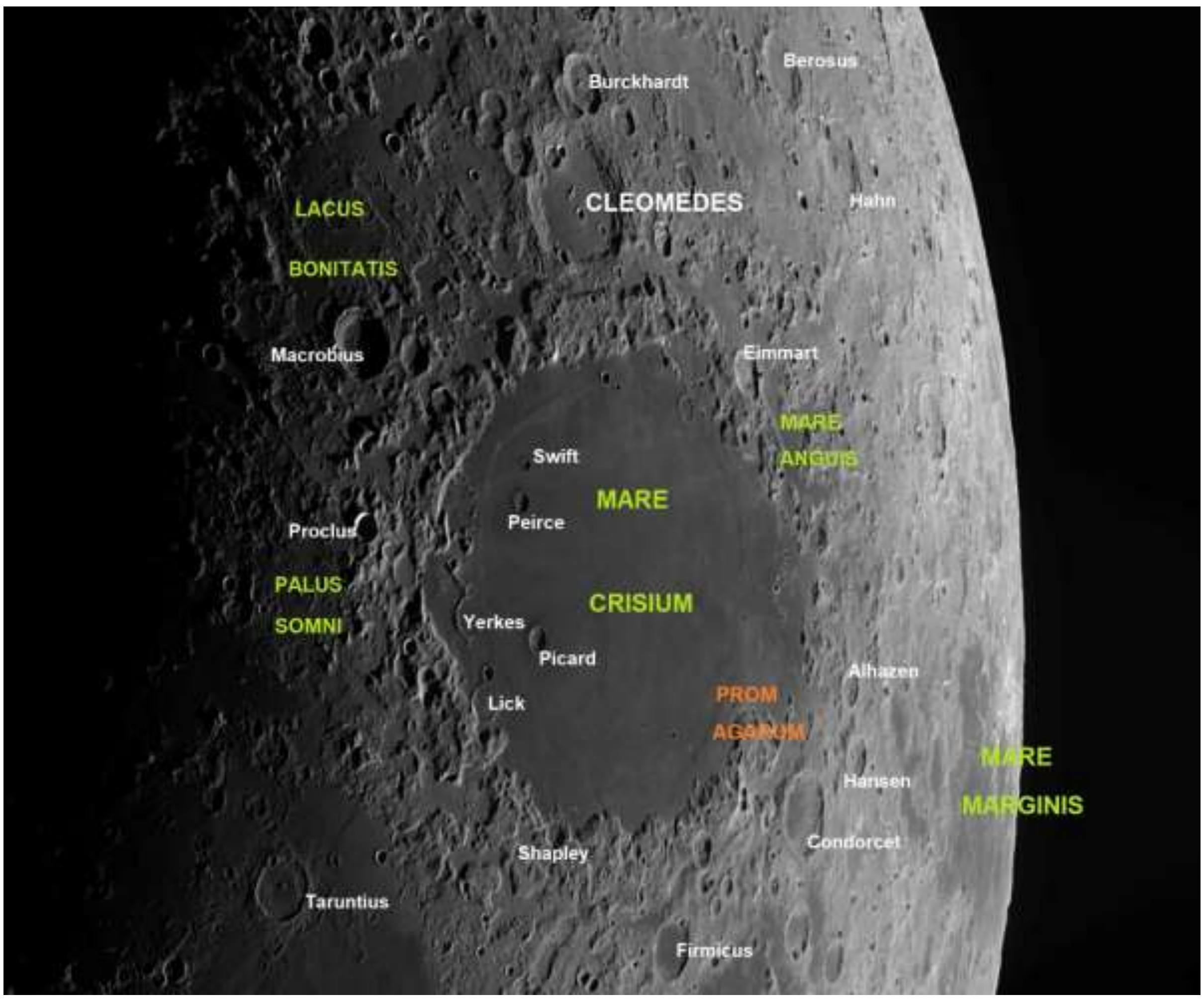
Lunar Topographic Studies
Kepler to Marius

MARE CRISIUM: A REVIEW OF MAJOR FEATURES

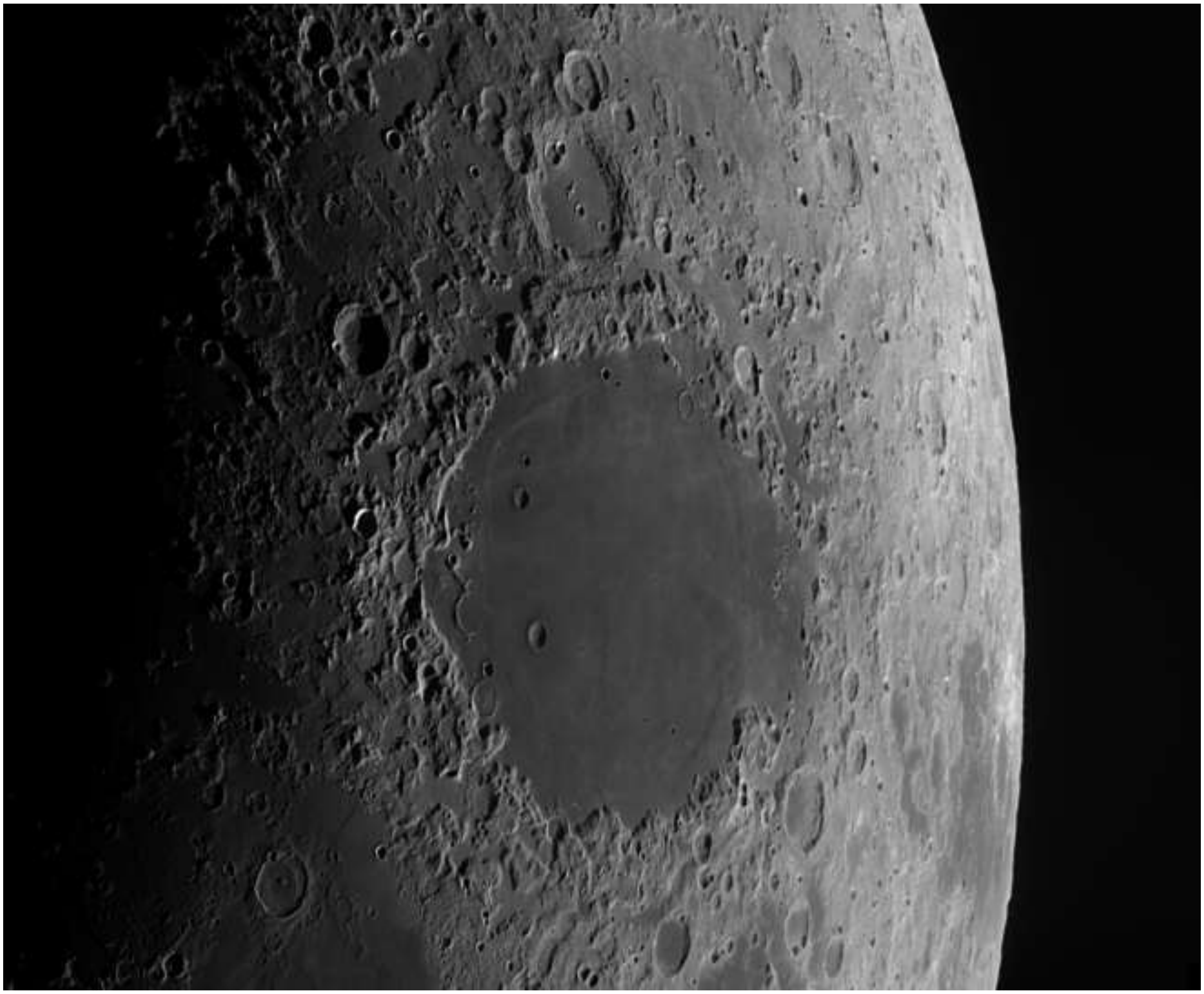
Jeff Grainger

Visible to the naked eye and accentuated because of its isolation from other lunar mare – the only nearside mare to have no lava connection to adjacent mare/maria.
A REGION survey of the area at different stages of the lunation has already been conducted.
Aspects of the Crisium area considered here:

The multi-ring structure of the Crisium basin.
Mare features (J100: #10)
Proclus and it's oblique-impact ray system (J100: #12)
"O'Neill's Bridge" (J100: #55)
The adjacent floor-fractured crater Taruntius (J100: #31)



Lunar Topographic Studies
Mare Crisium, A Review of Major Features



Mare Crisium and Mare Marginis: 4.46 days 18.05 UT February 24 2023 [133]
[Altitude: 42°25' Azimuth: 220°43' Libration: 6.8° @ PA 85°]

Feature	21C	Duplex	Moore
Proclus	2 A3	6	516
Picard	2 C3	2	493
O Neill's Bridge	2 B3	6	---
Prom. Agarum	2 F4	2	152
Mare Anguis	2 E1	2	78

Lunar Topographic Studies
Mare Crisium, A Review of Major Features

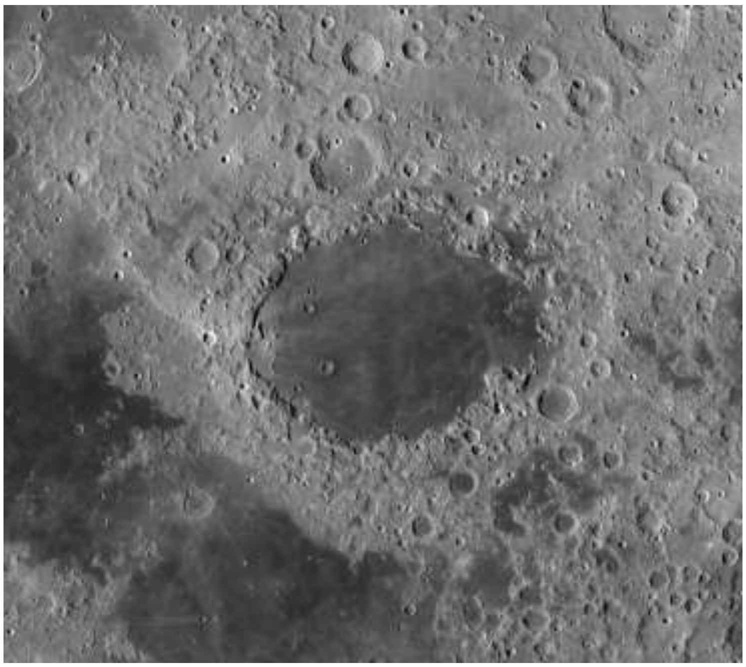
The Crisium Impact Basin: Ring Structures

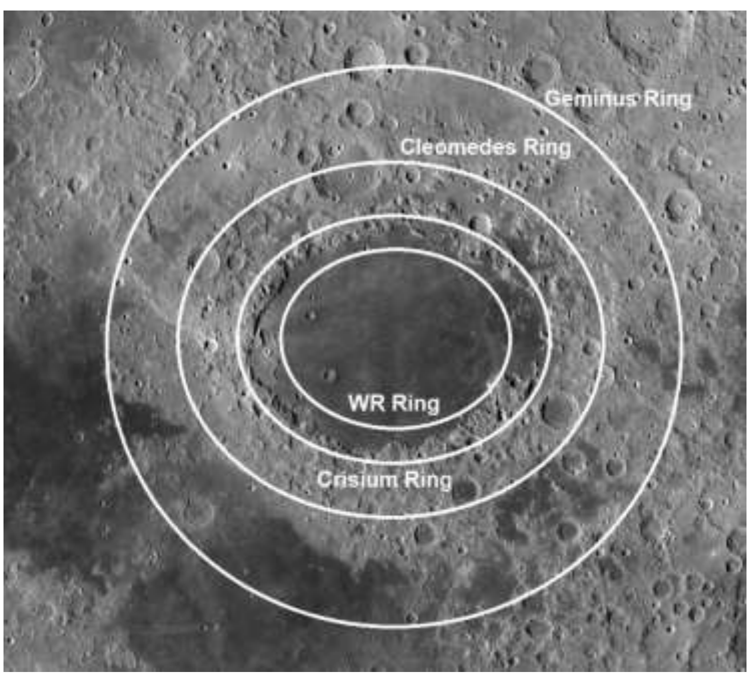
In common with other Mare, such as Imbrium, Humorum, Nectaris and Orientale, the Crisium area shows indications of a Ring structure.

Extensive discussion of the formation of Impact Basins and the Crisium Basin structure can be found in Wood [1] [2]

There are 3, maybe 4, well-defined Ring structures in the Crisium area. The suggested formations are indicated below, with the Ring diagram following the example of Wood.

The Wrinkle Ridge Ring is discussed in a later section.



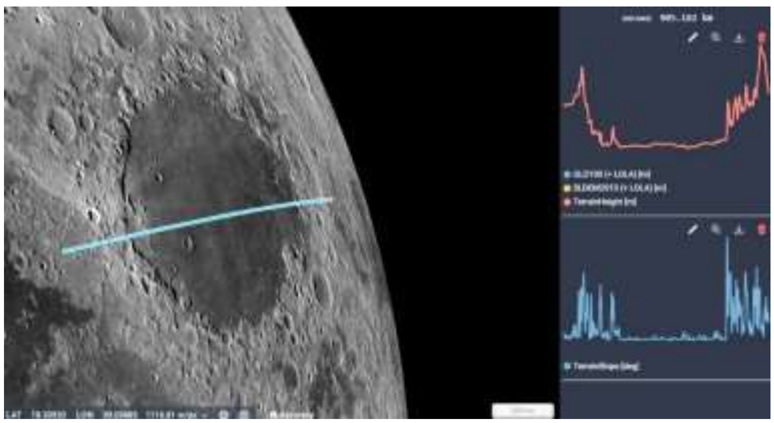


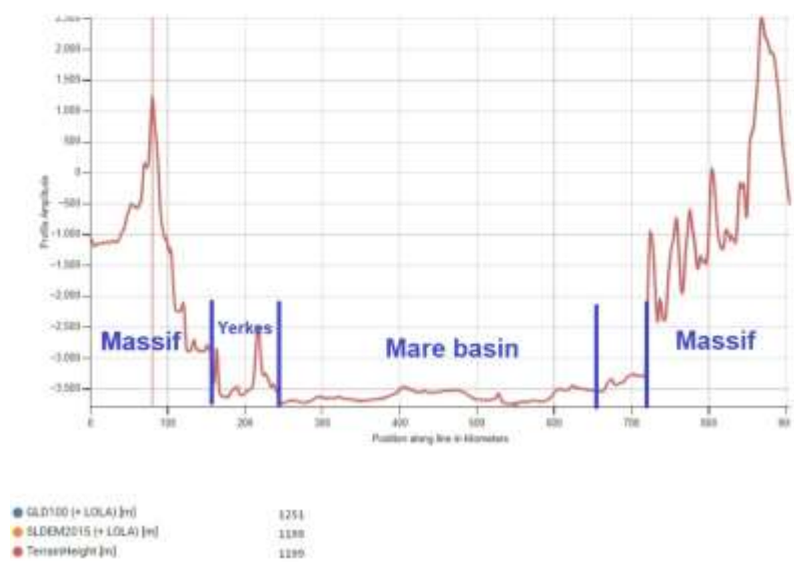
Ring Number	Ring Name	Approx. Ring Diameter (km)	Ring Diameter Ratio (D_{n+1}/D_n)	Features
1	Wrinkle Ridge	350	500/350 = 1.4	Near-continuous dorsa/dorsum on lava floor
2	Crisium Massif	450-550	650/500 = 1.3	Encircling mountain ring
3	Cleomedes	700	1080/700 = 1.5	Fragmentary ring indications to the North of the Mare
4	Geminus	1080		Ridge indications concentric to Mare

Basin Profiles:

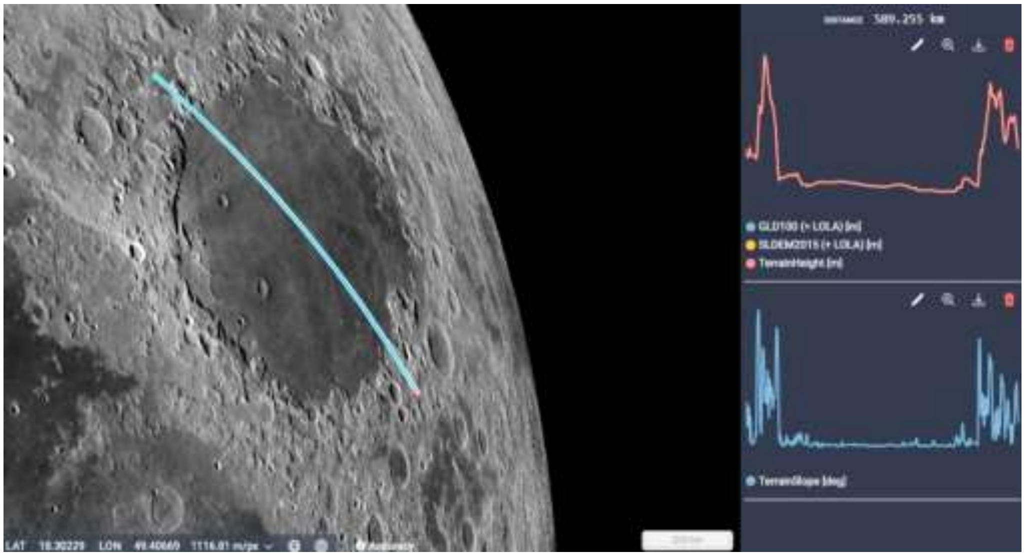
To give some kind of indication of the topography of the basin area, here are 2 randomly chosen profile sections:

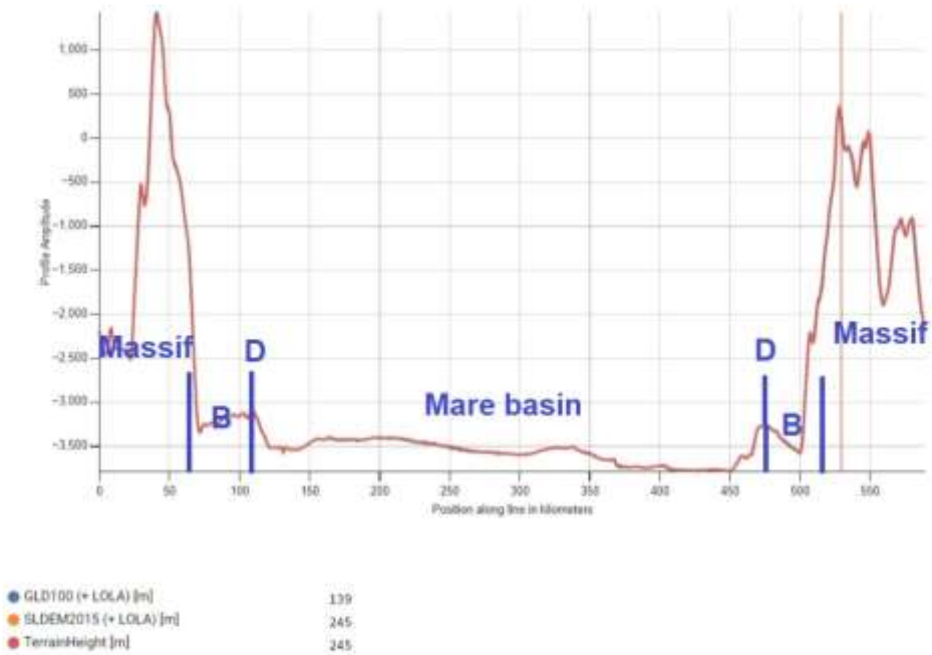
Profile from ~ W to E:





Profile from ~ NW to SE:





B = “Bench” region D = Dorsum region

The diameter estimates from numerous LRO profiles suggest average values in the table above. These values are roughly in line with the suggestion that the ratio of successive ring diameters in lunar multi-ring basins should be $\sqrt{2}$ (Hartmann and Wood, 1971 [3]).

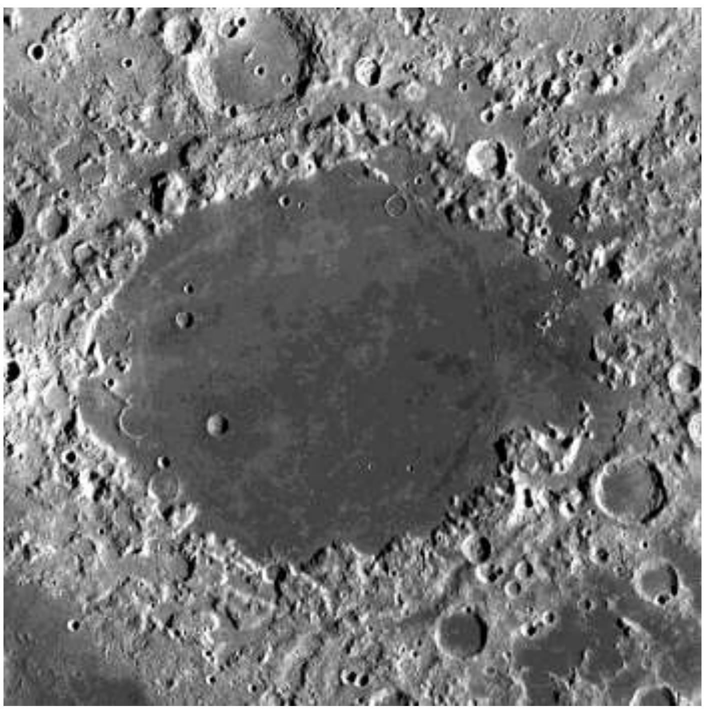
The Bench (B), Dorsum/Dorsa (D) and Massif features are discussed in later sections.

Lunar Topographic Studies
Mare Crisium, A Review of Major Features

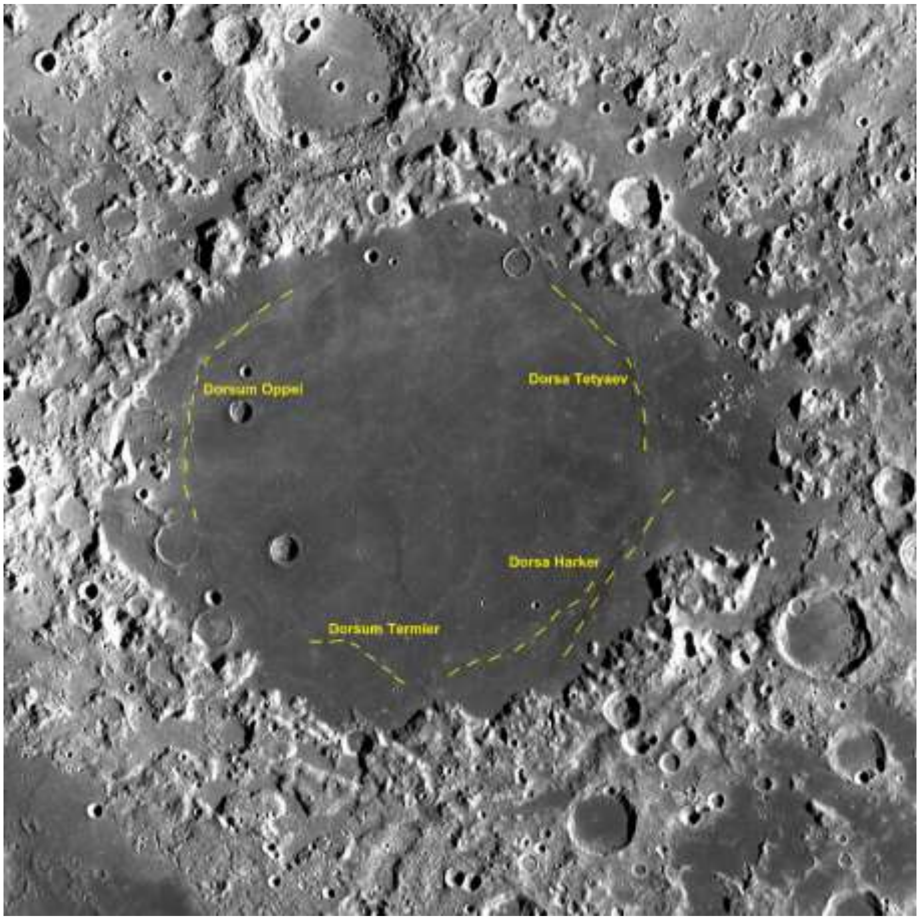
Notable Features within the Mare area: Wrinkle Ridges

- WRINKLE RIDGES (standard IAU nomenclature = dorsum or dorsa) are commonly found on the basaltic plains that constitute the lunar maria.
- They are low, sinuous RIDGES formed on the mare surface that can extend for up to several hundred kilometres. Wrinkle ridges were formed due to underlying (TECTONIC) changes in the structure of the basalts after the internally produced lavas cooled and solidified.
- Folding and faulting - buckling of the surface - lead to surface ridges, often irregular in shape, that look wrinkle-like – hence the name.
- They frequently outline ring structures buried within the mare, follow circular patterns outlining the mare, or intersect protruding peaks.

- Very low sun-angles – at times near sunrise or sunset (terminator adjacent to Crisium) – allow the wrinkle ridges to be observed.
- The elevation of the sun in my own imagery is a bit too high for best effect – imaging Crisium from 15 to 17 days, post full moon – is a target, so the image below is an overhead LRO composite.
- Enlarging the first image reveals an almost complete wrinkle ridge, along with wrinkle features running N -S. The ring may well be associated with the ring structure of the original RING BASIN.



The 4 principal sections of this "ring" are highlighted below, with relevant data in the table.[4]



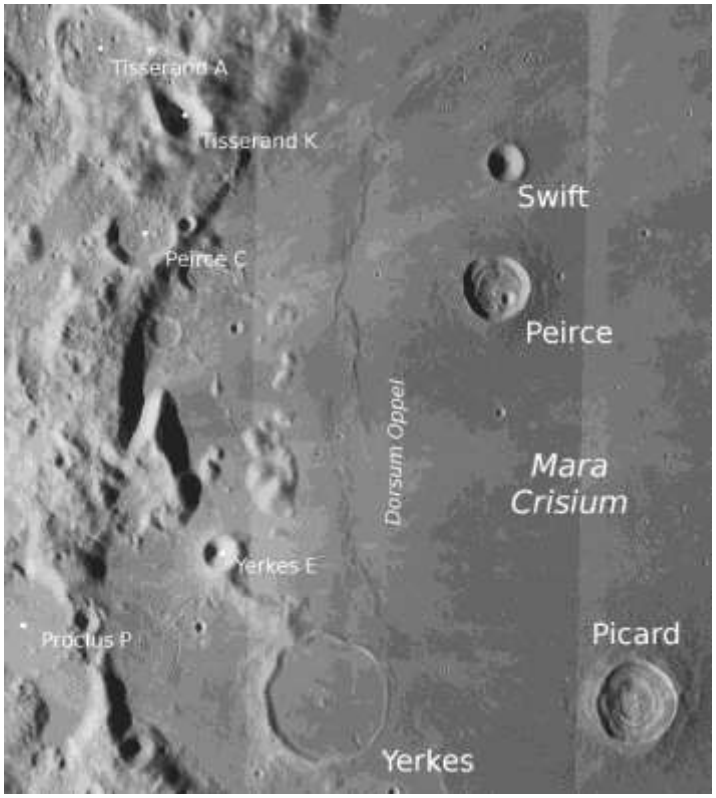
Feature	Location	Length (km)	Moore FOM
Dorsum Oppel	NW Crisium	298	52
Dorsa Tetyaev	NE Crisium	139	35
Dorsa Harker	SE Crisium	213	27
Dorsum Termier	S Crisium	90	55

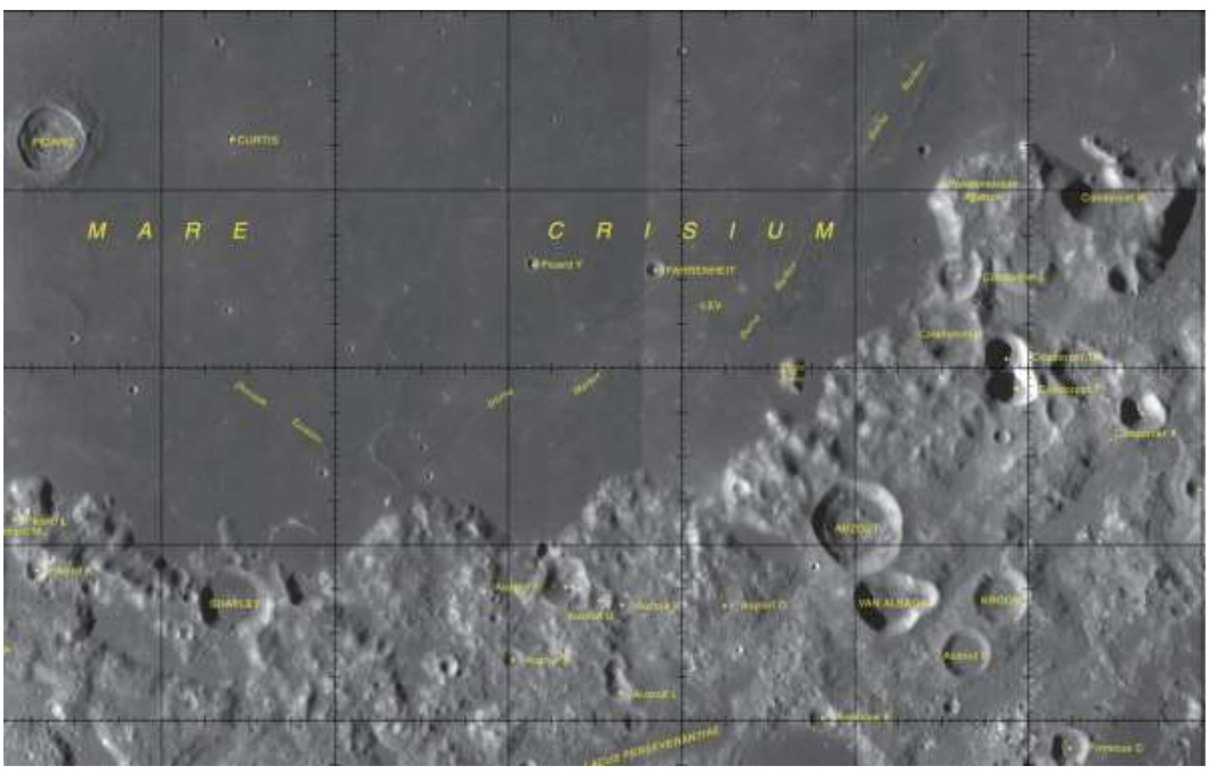
LRO-based imagery with more detailed annotation is on the next page.

Profiling Data:

[Quote from Wood, 2003] [5] :

"These (wrinkle) ridges are only 100 to 150 meters high. The ring ridges are not just ridges but mark the inward edge of a bench or annular plateau. Along the southern side of the basin, the bench surface is on average about 200 meters higher than the immediately adjacent interior basin surface.

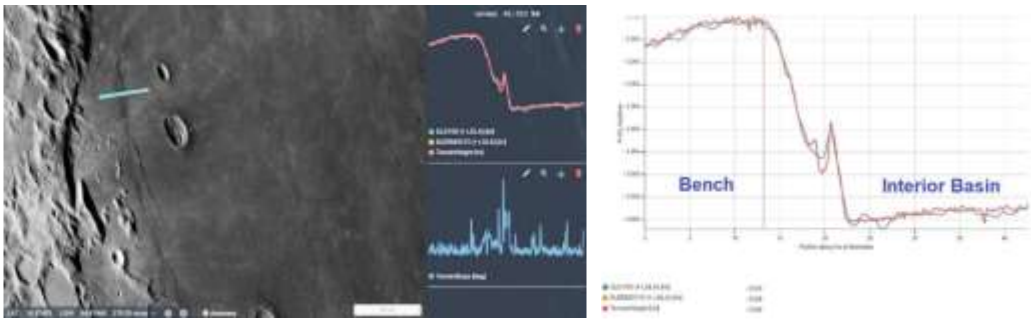


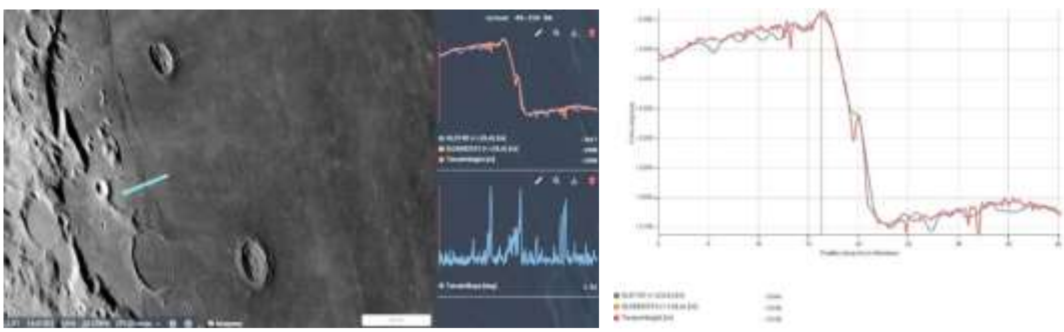


Lunar Topographic Studies
Mare Crisium, A Review of Major Features

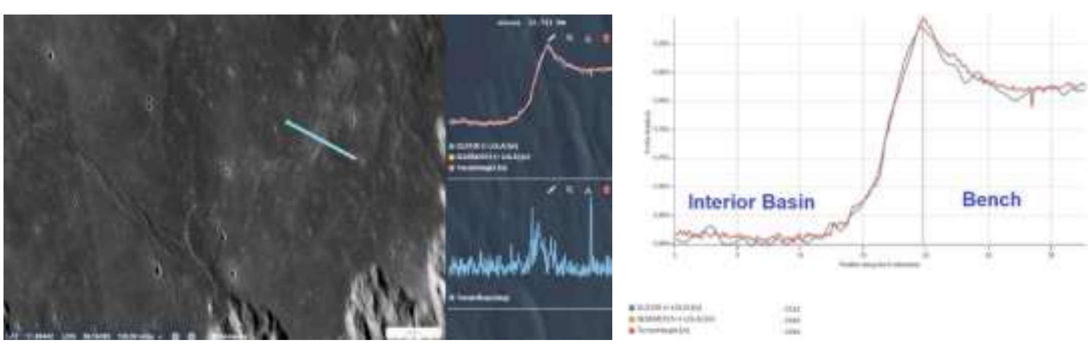
In fact, all the Crisium craters that have been breached by mare lava (Lick, Yerkes etc.) are sited on the shallow bench. Presumably, the interior of Crisium is so deep that craters that formed on the original basin floor are completely buried by lava."

Profiles W-E across D Oppel:





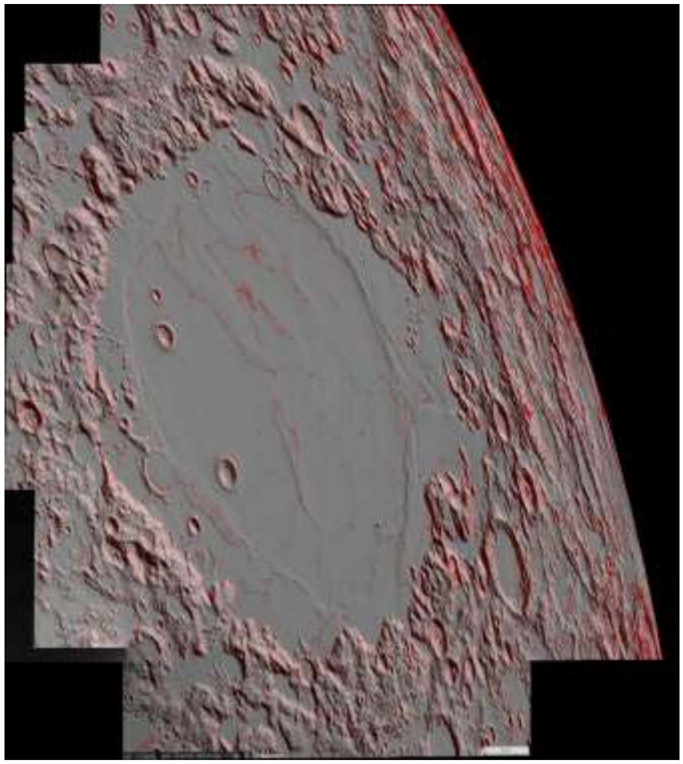
Profile NW-SE across D Harker:

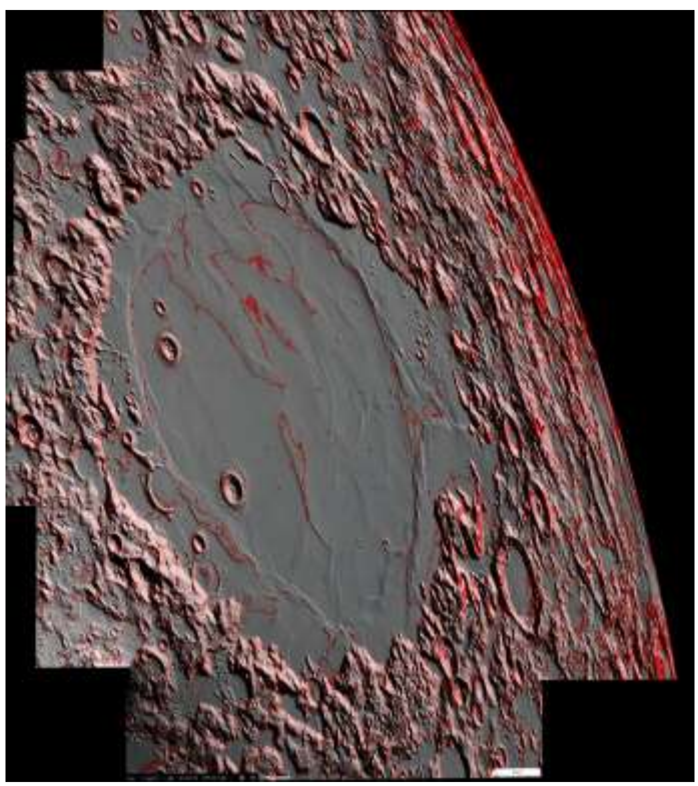


The profiles here, using LRO data, suggest the Bench is ~ 300-350m above the interior basin.

Contour Data:

ENLARGE for more detail. The second image has been contrast enhanced to emphasize the Wrinkle Ridges. The Bench and Interior Basin are very obvious here.





The Crisium Massif and Prom. Agarum

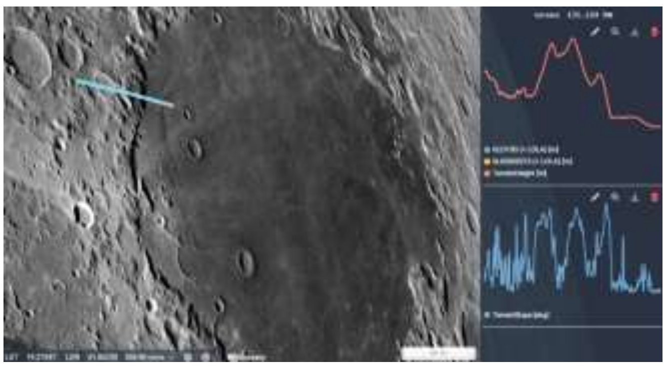
The mountains which encircle much of the Mare Crisium do not appear to have any specific name, so will simply be referred to as the “Massif”.

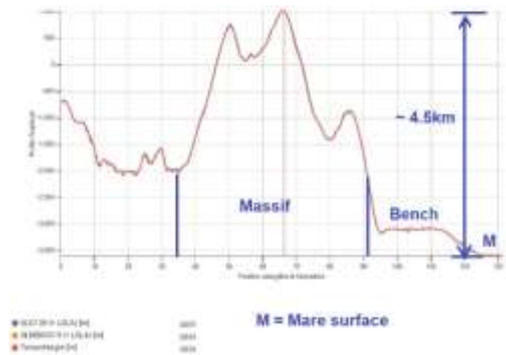
As indicated on the Basin Profiles, the Massif tower is some 4-5km above the mare surface.

A sampling of these hills, taken in the NW and SW quadrants is given below:

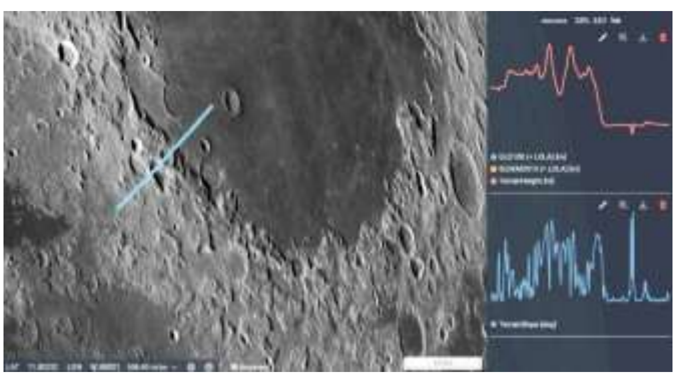
Crisium Massif Profiles:

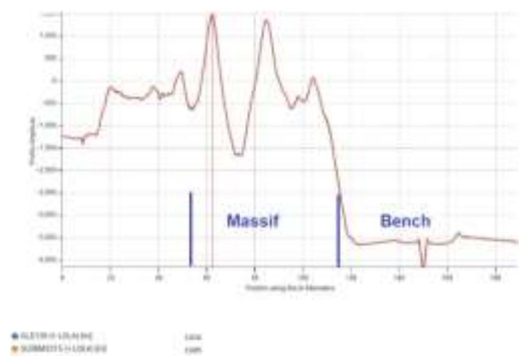
NW Profile:





SW Profile:





The Massif ring mountains rise, typically 4-5km above the mare surface in the interior basin (the Mare Crisium itself).

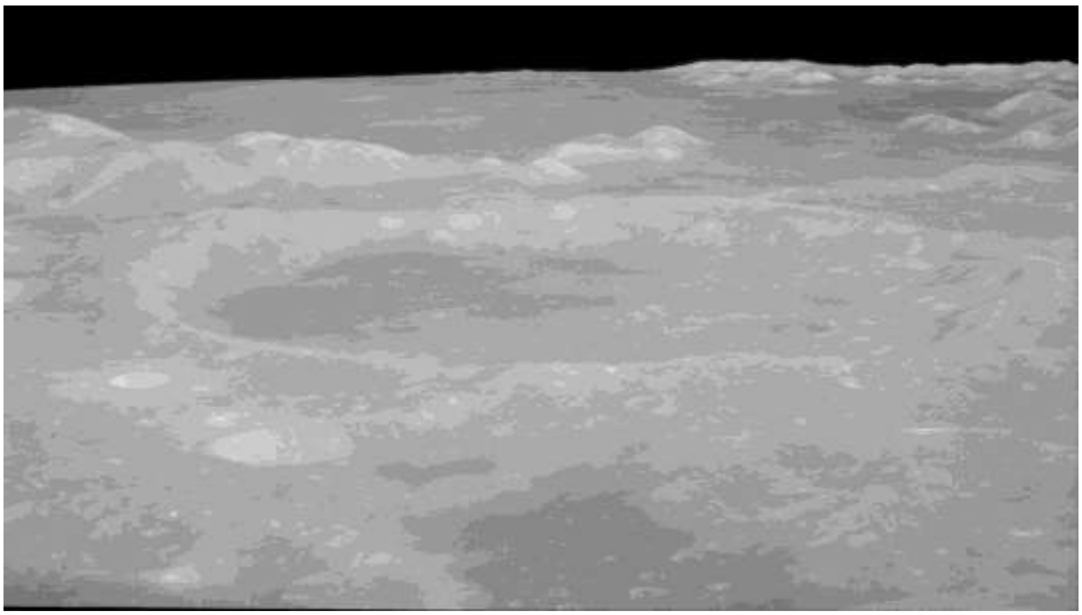
The range itself is typically 50-60km deep, sometimes adjoining adjacent highlands, as in both cases shown here.

One especially isolated mountain area is the Promontorium Agarum in SE Crisium.

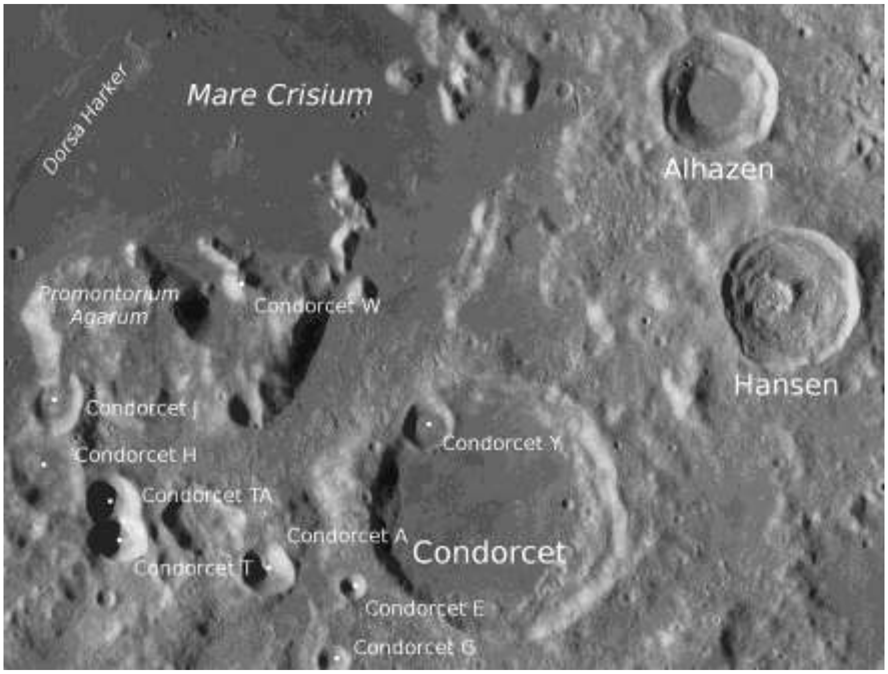
Promontorium Agarum and Condorcet crater:

- Prom. Agarum is a raised mountainous outcrop protruding into the SE of Mare Crisium. One of the highest areas surrounding the Mare.
- The mountain block is around 50km across in the SW-NE direction and ~ 60km on a NW-SE axis. The LRO profiles that follow give further details.
- The maximum height of the feature is ~ 5.5km relative to the mare surface.

Apollo 11 image of the SE Crisium area, looking NW. The crater in the foreground is Condorcet, 75km in diameter. [AS11-43-6472] Agarum is to the upper left.

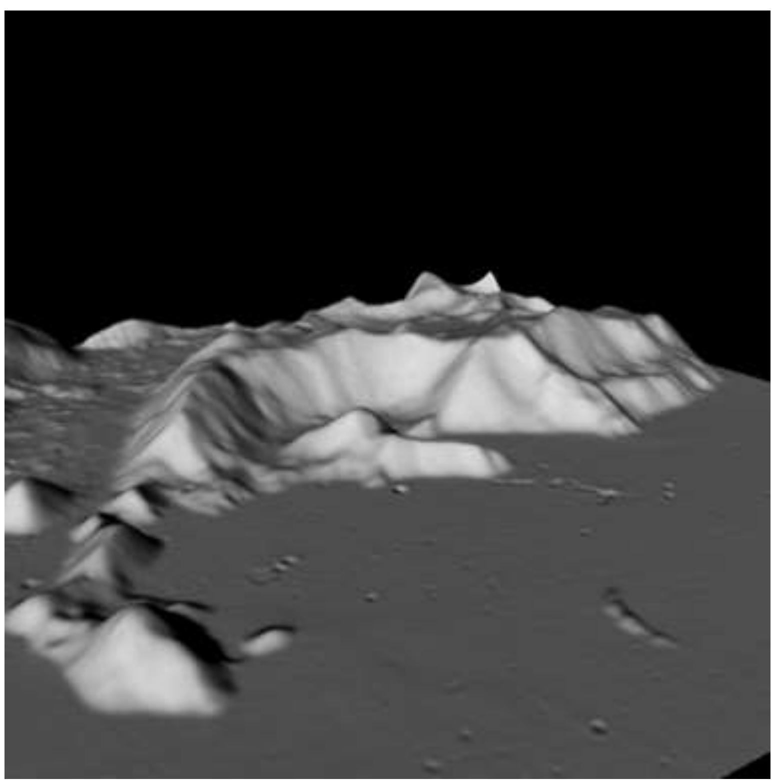


Putting this image into context (LRO image) …



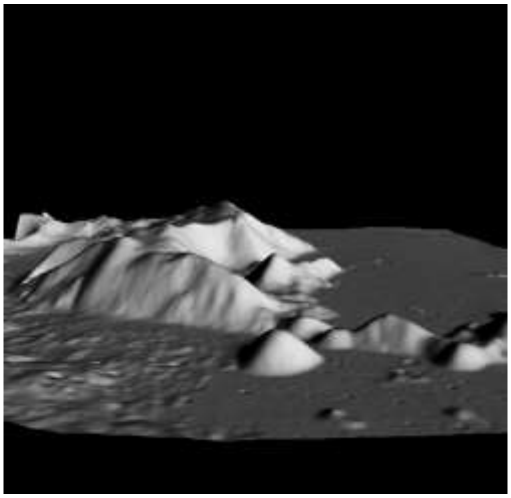
Rendered views of Prom. Agarum

Looking SE. Perspective projection, x2 vertical exaggeration.



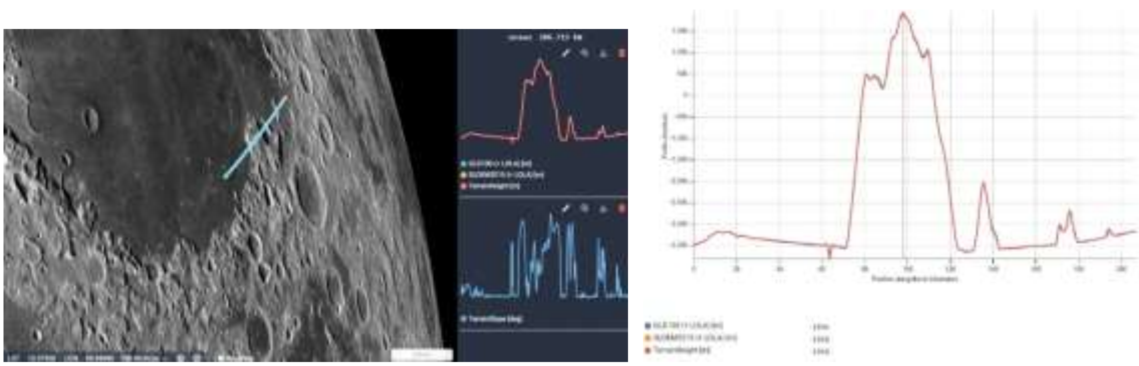
Lunar Topographic Studies
Mare Crisium, A Review of Major Features

Looking W. Perspective projection, x2 vertical exaggeration.



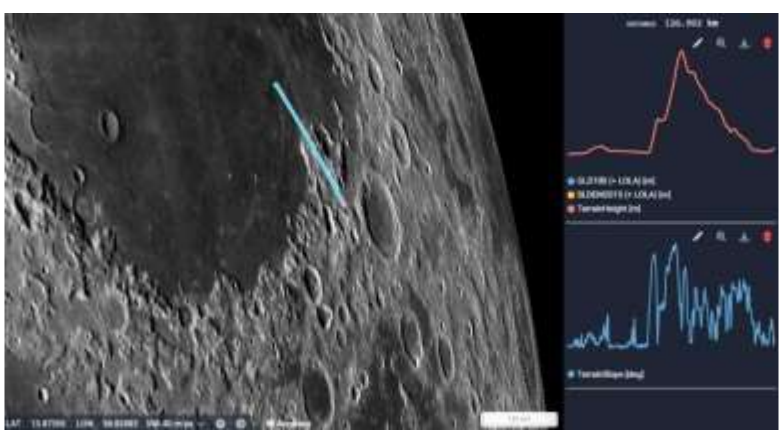
Agarum Profiles:

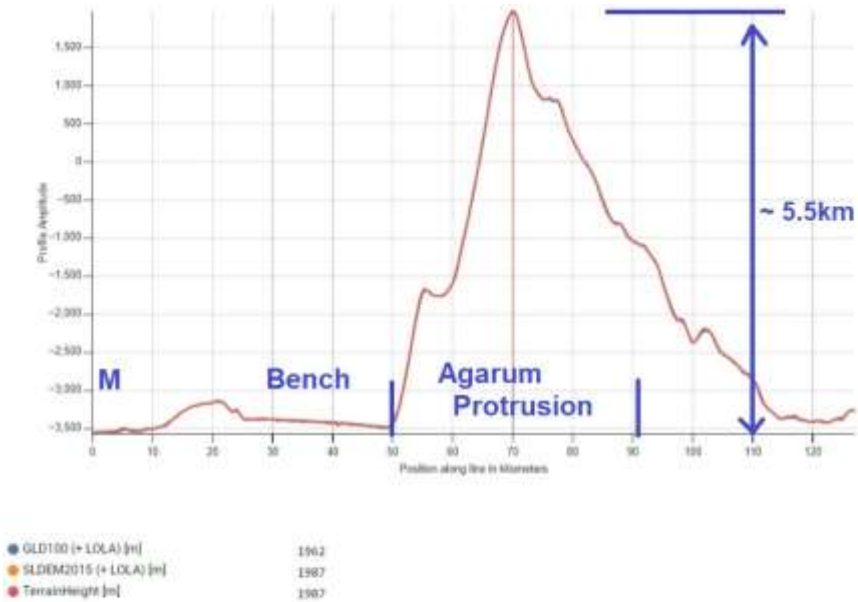
Profile SW-NE:



The slope on both SW and NE of Agarum is significant: rising ~ 4km above the lava surface in 10km – roughly a 20° incline!

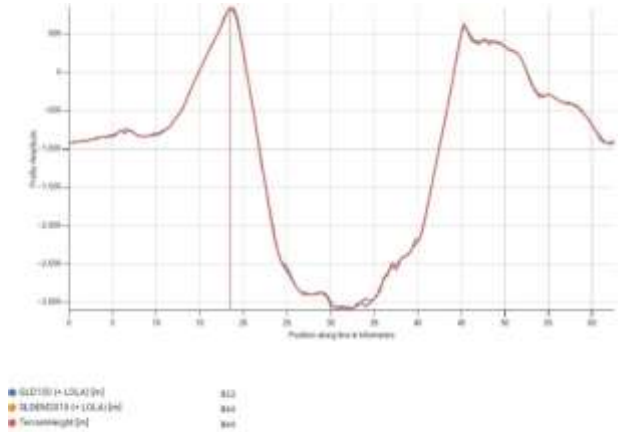
Profile NW-SE:





Proclus Crater and Oblique Impacts

Crater Proclus (Lat. 16.1N, Long. 46.9E) is a 27km diameter, "young" (Copernican era) crater just W of the western Crisium Massif.

Apollo 17 image [AS17-150-23046]

- The floor of the crater displays impact melts and fractures.
- The crater walls are very bright ("high albedo") – one of Proclus's two main claims to fame (second brightest crater on near-side of the Moon, after Aristarchus).
- The crater walls are relatively steep (average 20°). The Depth/Diameter of Proclus is ~ 0.15, compared to e.g. Tycho and Theophilus ~ 0.05 (see LRO profile, above).
- But the most notable feature is the PROCLUS RAY SYSTEM.

The two images that follow show the Crisium area at very different points in the lunation – 5.7 days and 14.0 days.

In the first image the Proclus ray system is just apparent – as is their asymmetrical distribution, with the noticeable absence between NW and S of the crater visible.

Imaging data: 5.67 days 20.06 UT April 25 2023 [159]

[Altitude: 46°06' Azimuth: 251°56' Libration: 6.4° @ PA 156°]

The dark-grey area to the west of Proclus, especially clear in contrast to the ray areas, is a named highland area, Palus Somni.

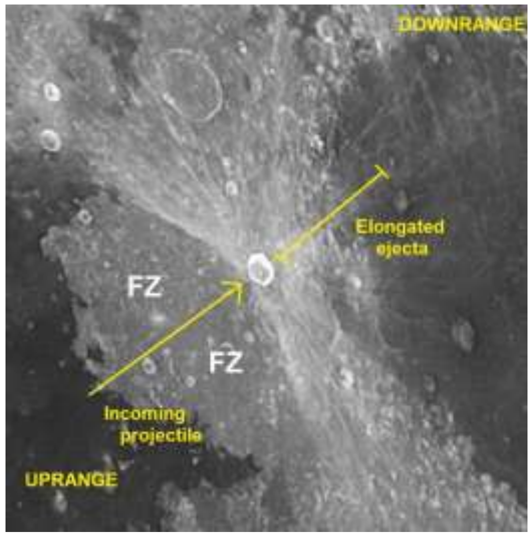
In the second image, the Proclus ray system is in “full swing” with the asymmetry prominent and the “butterfly” fan of the rays spreading predominantly NW-NE and S-SE.

Imaging data: 14.00 days 22.52 UT December 07 2022 [105cr]

[Altitude: 58°18’ Azimuth: 152°52’ Libration: 4.7° @ PA 130°]

Ray systems and Oblique Impacts

The asymmetry of the Proclus ray pattern, with its “Forbidden Zone” in the UPrange direction (direction of incoming projectile, in this case the SW) and increased ray frequency in the DOWNrange direction (NE into Crisium) provides detailed clues about the crater/ray origins.

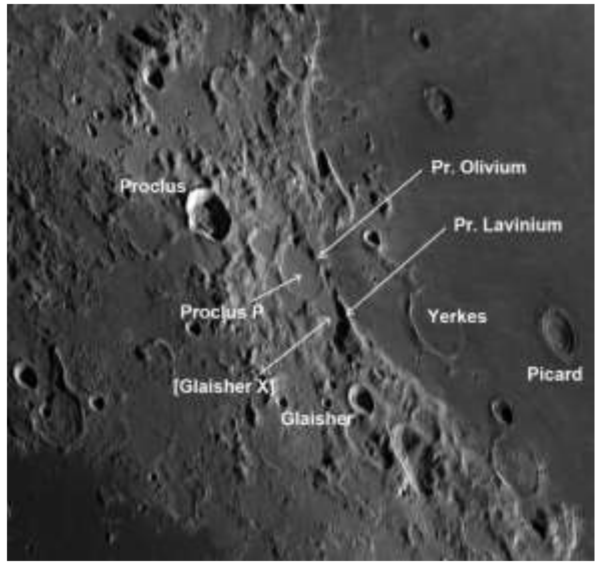


- Such a distribution of rays is indicative [6] of an impacting bolide, travelling at tens of km/s, at an impact angle (relative to the ground) of 10°-15°.
- Other than impacts at substantially < 10°, the impactor is obliterated on impact and the resulting compaction and rebound generates an explosion resulting in a (near) circular-shaped crater.
- The notable pair of Messier and Messier A (Pickering) in the Mare Fecunditatis is an example of the latter case, with an impact angle of < 5°.
- Wood [A] suggests that the ejecta pattern of the Crisium basin, along with the elongated shape in the W-E direction, is suggestive of a low-angle, oblique impact – though with impactors on a much larger scale (as were available > 4bn y ago).

Miscellany 1: “O’Neill’s Bridge (ONB)”

There are 3 inter-related articles on Wikipedia that are worth consulting:
“Promontorium Lavinium” [7], “Promontorium Olivium” [8] and “O’Neill’s Bridge” [9]
The latter article provides an extensive discussion of the furor surrounding the events of 1953-54.

The images below show the relevant area of W Crisium, with an enlarged, labelled view of the “key players” in the story….



Crisium with W area enlarged: 5.67 days 20.06 UT April 25 2023 [159]
[Altitude: 46°06’ Azimuth: 251°56’ Libration: 6.4° @ PA 156°]

I can do no better than to directly quote the description of the ONB area given in the Wiki articles on Pr. Olivium and Lavinium.

Bounding the tiny break in the western rim of the Crisium Basin are two headlands that almost meet. To the north is the area east of the crater Proclus P, and to the south is the eastern wall of Glaisher X.
Each of these headlands was named in the late 1800's by the English selenographer William Birt. He called the northern one PROMONTORIUM OLIVIUM and the southern PROMONTORIUM LAVINIUM. Both of these names were included in *Named Lunar Formations* and in the *System of Lunar Craters*, but do not appear in the current list of IAU names.
Pr. Olivium is broad and flatly rounded in cross-section, it appears to be the continuation of the Crisium Basin rim. Pr. Lavinium is narrower with a more V-shaped profile - it casts the more dramatic shadow under low illumination.
The southern tip of Prom. Olivium is the site of the alleged, and infamous, “O’Neill’s Bridge”.

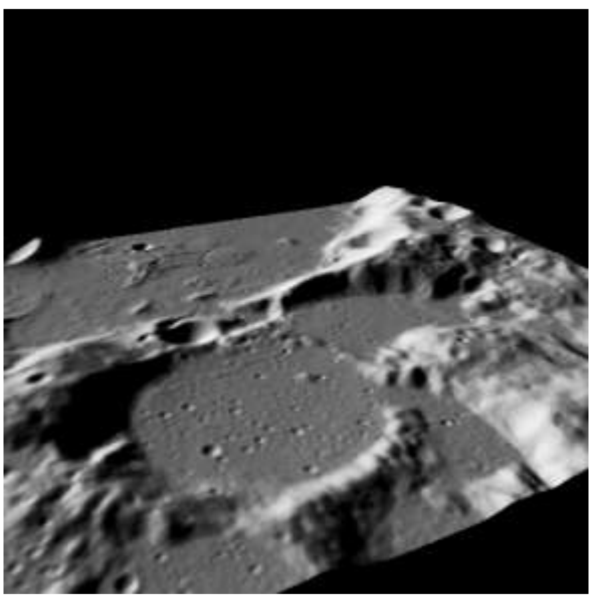
Here's an image I took with the W Crisium area near the terminator. The two Promontories, the features in the labelled diagram, and Dorsum Oppel (to the N) are clearly visible.

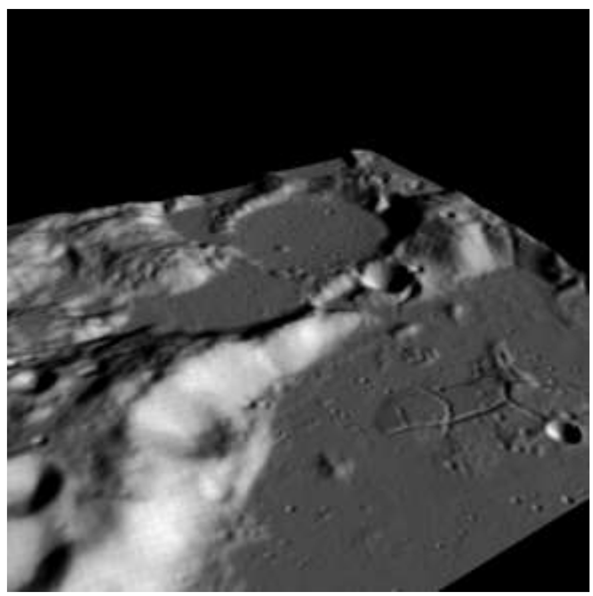
Western Crisium and O'Neill's Bridge area: 17.26 days 04.08 UT October 13 2022 [48]

[Altitude: 52°14' Azimuth: 217°56' Libration: 4.5° @ PA 108°]

To give a better idea of the terrain, as mapped by LRO, an overhead view of the Prom area is presented, along with a couple of Renderings.

The small crater near the southern tip of Olivium, once referred to as "Proclus PA" is suggested as the feature that provided the shadow to suggest the controversial bridge structure.





Looking SE Looking NW

Both Perspective projections, no vertical enhancement.

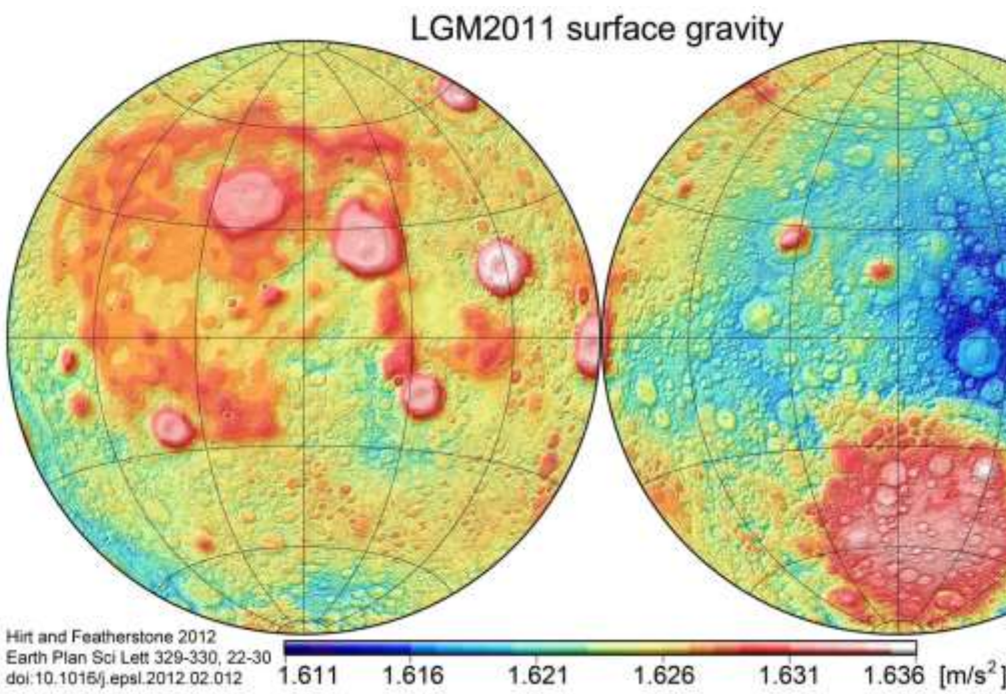
Miscellany 2: Gravitational and Magnetic Anomalies

The acceleration due to gravity on the surface of the Earth is around $9.8 ms^{-2}$. Since the Moon is a much less massive body (~1/81 mass of Earth), its gravitational field is weaker and averages out at ~ $1.625 ms^{-2}$ at the Moon's surface.

This is around one-sixth as strong as on Earth.

Just as the gravitational field strength varies across the surface of the Earth, due to the Earth's non-spherical shape and localized density variations, so the gravity field is variable on the Moon.

The diagram indicates this variation [10]:

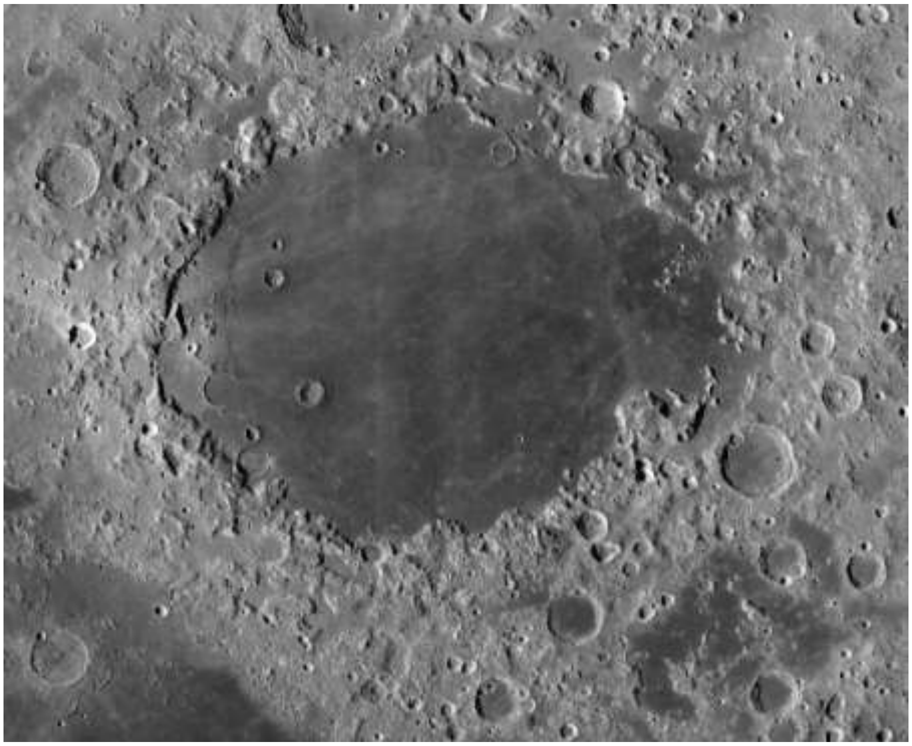


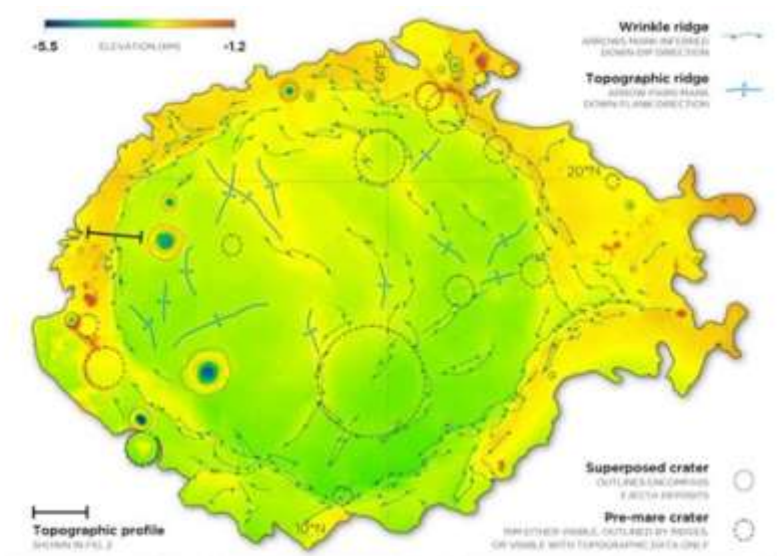
Certain regions display large positive gravitational anomalies – shown in red on the chart. These often correspond to mare impact basins, such as Imbrium, Serenitatis, Orientale, Nectaris and CRISIUM.

These regions displaying increased gravitational effects are often described as MASCON sites.

The Mascon effects may be due to regions of thicker and denser than normal mare basaltic lavas. However, there may also be a contribution from mantle-crust intrusions under these areas. Whatever the cause, the gravity variation is sufficiently large to cause significant problems for satellites in low-lunar orbits.

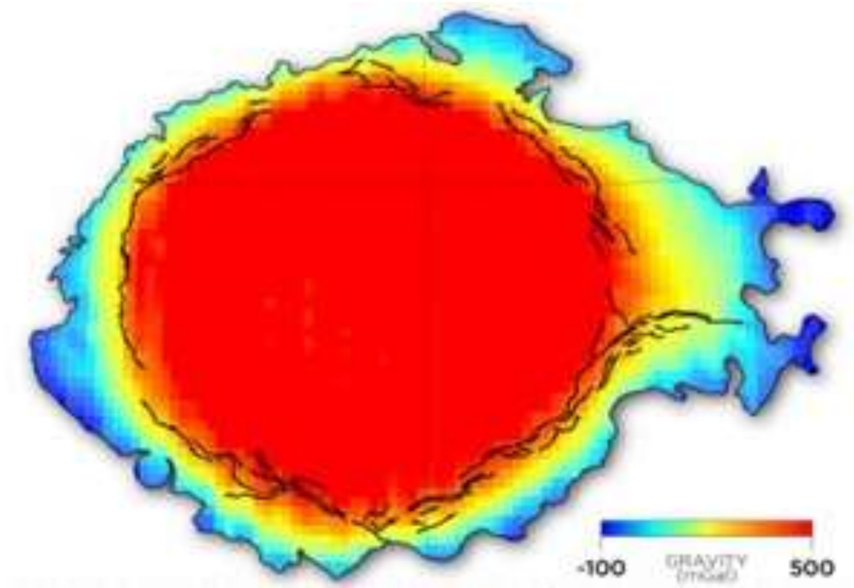
A series of images may be of interest, the first two being LRO-based visual imaging and laser-altimetry-based topographic [11] images of the Crisium area. Chuck Wood's nickname of the "(Angel) Fish" for the Mare Crisium area becomes clear.





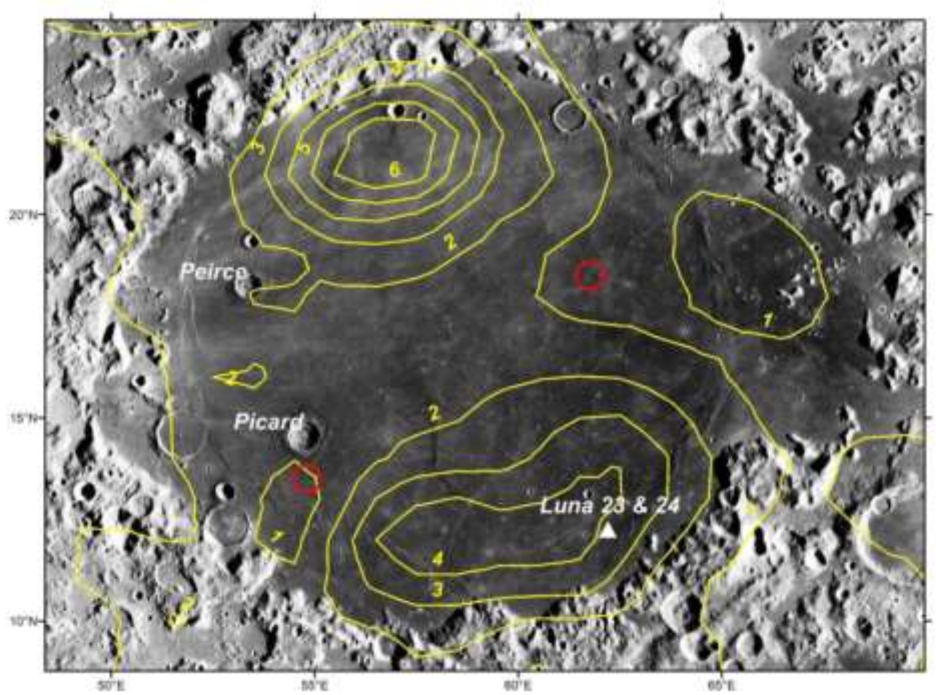
The elevation key ties in with the earlier Profiles, indicating the mare surface to be ~ 4km below the top of the Massif. The indication of pre-mare-lava flooding is interesting.

Here is the corresponding chart for gravity anomalies across the region [11]:



The Crisium Mascon is nearly entirely bounded by the Wrinkle Ridges described in a previous section. This behavior seems to be consistent across the other Mascon-related maria.

The chart below shows another physical variation across the Crisium Basin – Magnetic Field Strength. The contour lines are indicative of field excesses [12].



Links have been made relating the positive anomalies to iron-rich deposits from bolide bombardment, and the information used to suggest bombardment trajectories.

Lunar Topographic Studies
Mare Crisium, A Review of Major Features

References

1 Wood The Modern Moon Chapter 2, p.18

2 Wood The Modern Moon Chapter 10, p.91

3 Hartmann WK and Wood CA (1971) Moon: Origin and Evolution of Multi Ringed Basins

The Moon, vol.3, 1, pp. 3-78

4 Wikipedia "Characteristics of Mare Crisium"

5 Wood The Modern Moon Chapter 10, p.95

6 Wood The Modern Moon Chapter 10, p.93

7 Wikipedia "Promontorium Lavinium"

8 Wikipedia "Promontorium Olivium"

9 Wikipedia "O'Neill's Bridge"

10 Hirt C and Featherstone W (2012) A 1.5km-resolution gravity field of the Moon

Earth and Planetary Science Letters 329-330:22-30

11 Byrne P, Klimczak et al. Deep-Seated Contractual Tectonics in Mare Crisium

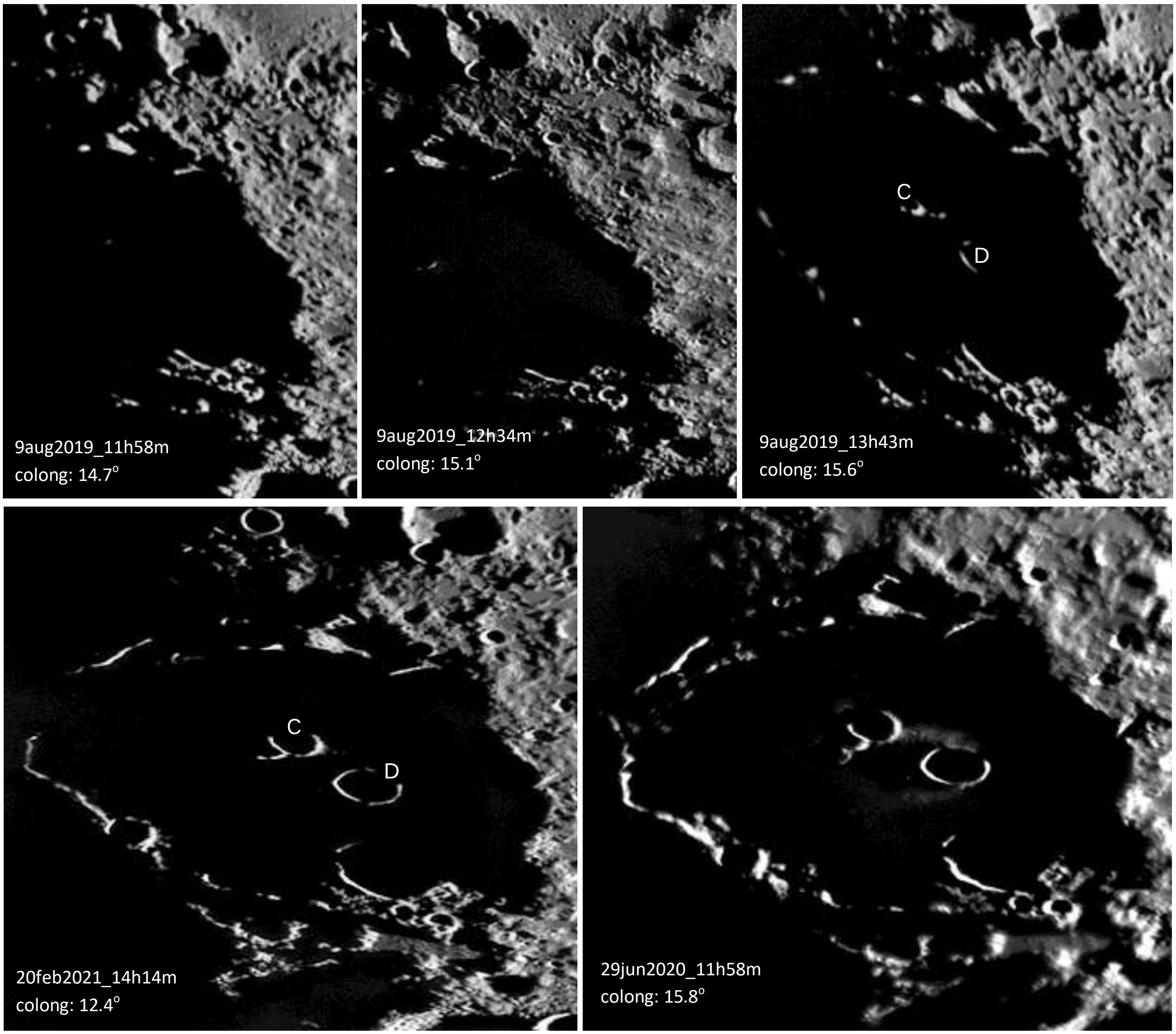
45th Lunar and Planetary Science Conference (2014)

12 Fuqua H, Weber R et al. (2021) Lunar Geophysical Network Landing Sites Science Rationale

Eyes of Clavius

KC Pau

Around the 8-day moon, Clavius will have a fascinating scene of claire-obscure effect for observers to enjoy. The effect is well-known as “Eyes of Clavius”. The following images self-explain the sequence of events on the scene. The best time to observe the Eye of Clavius is between 12° ~ 18° colongitude. Libration and solar inclination will affect the position of the terminator on the moon.



A Good Morning of Imaging and Viewing

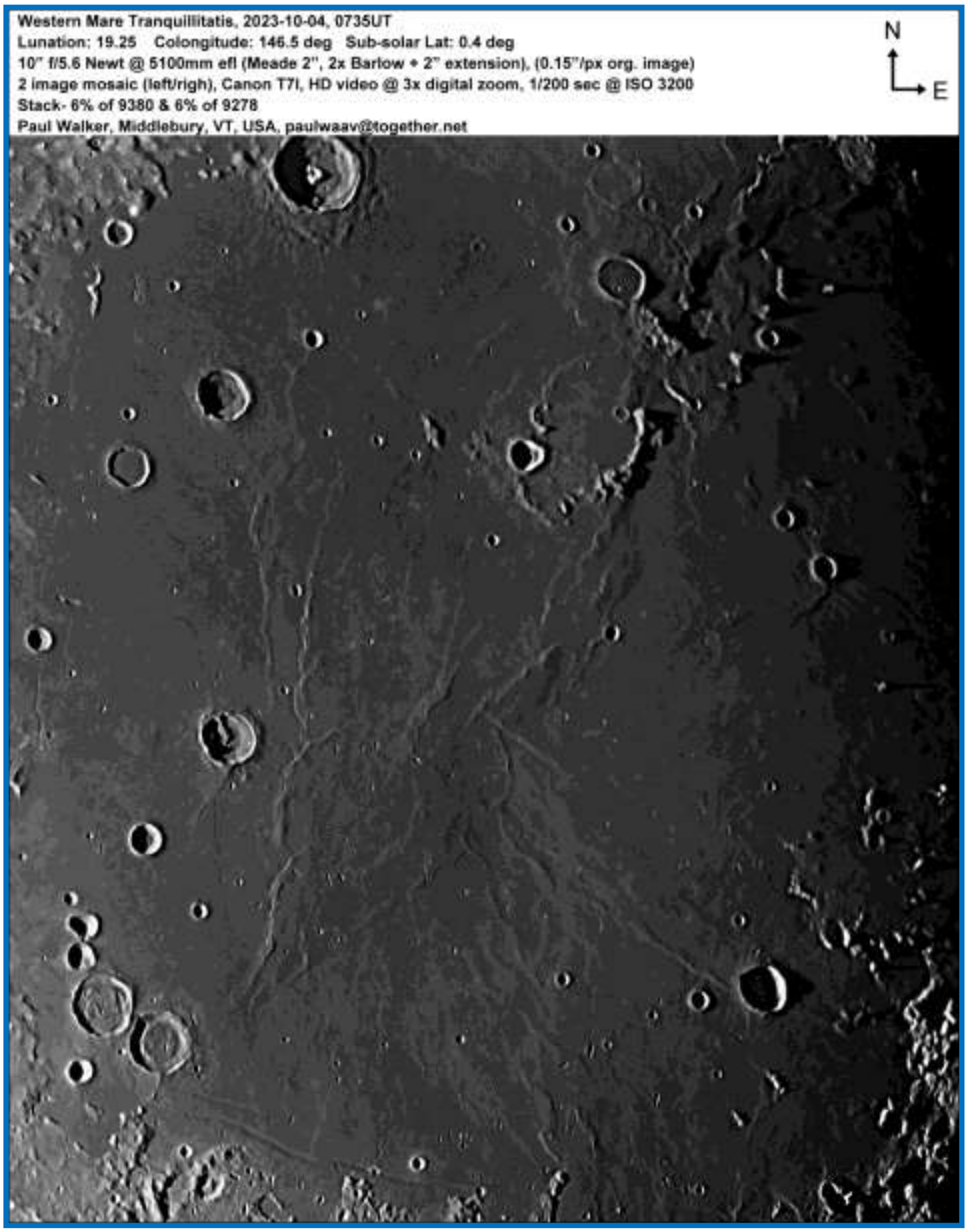
Paul Walker

From about 2:30 AM to 5:30 AM on morning of October 4th I viewed and imaged the Moon under good seeing conditions. I would have liked to taken advantage of the seeing by taking more images but that would have meant less observing. Not to mention more videos to stack and process. Here are some of the results from that morning.

I created the mosaics by first making one big mosaic using 6 of the 7 images created and then cropped that to create the images here.

Western Mare Tranquillitatis (Image 1)

Western Mare Tranquillitatis, *Paul Walker, Middlebury, Vermont, USA. 2023 October 04 07:35 UT, colongitude 146.5º. 10 inch f/5.6 Newtonian reflector telescope, 5,100 mm efl, Canon T7i camera.*



This is a mosaic of 2 images, the 3rd and 4th of the 7. The 1st and 2nd can be seen in the mosaic in my article, “Dorsa Smirnov and Eastern Mare Serenitatis” in the Focus on Dorsa Smirnov in this issue of TLO (see Image 3 there). The left 2/3’s of this image includes the area in an image of mine in the October TLO (see page 16) that I took a month earlier. The lighting angle is about 0.64 day earlier here so the features are more subdued. This image extends a little more to the west picking up Rimae Sosigenes. It also extends more to the east, covering about 2/3’s of Mare Tranquillitatis.

It shows most of the features in last month’s image so I won’t cover them here. On this morning I also as able to view most of the features mentioned in last month’s article. In this image, about half of the bottom of Arago (prominent crater on left, center) is visible. I noticed an interesting feature within. There appears to be a bridge of material going from the edge (11:00 position) to the center. I decided to check it out on LROC QuickMap, now that I have seen how easy it is to use. In the image it sure looks like this ridge is as high as the rim. However, LROC’s line/elevation tool shows that it is only a modest ridge rising 600-700 m above the bottom of the crater compared to the crater’s ~2200 m depth. It does appear to extend all the way to the top of the wall though, becoming a protrusion at the rim. The walls of this crater clearly slumped and this feature is apparently just some of that material (see the LROC QuickMap data in Images 2 and 3).

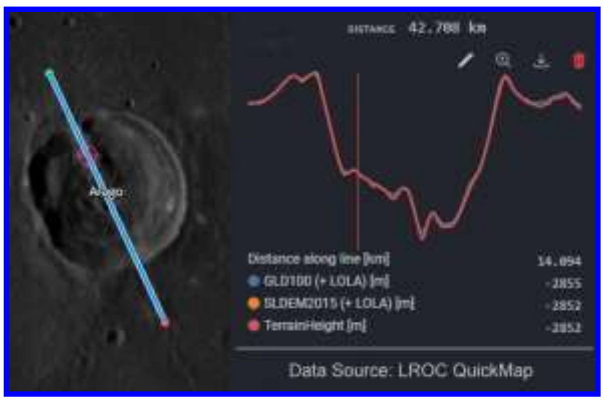


Image 2, Arago, LROC

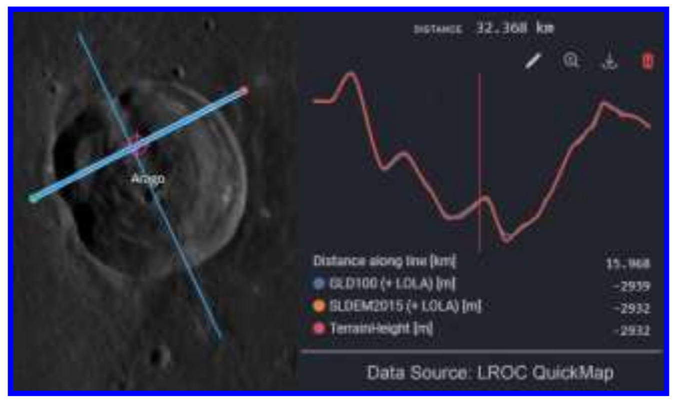


Image 3, Arago, LROC

On the right side (east) of the image from about the middle up are what appear to be several lunar domes with maybe some being small shield volcanoes. They are not labeled on the LAC charts nor the LROC QuickMap. I should see about getting other references. There are also a few low wrinkle ridges. Rima Jensen is in the upper right corner, about 1/3 way across in image, just right of the flat-bottomed crater, Jensen. Rima Jensen appears to have been a lava channel that flowed into the now almost filled crater Jensen R.

Sinus Asperitatis, Theophilus, Western Mare Nectaris (Image 4)

Another mosaic, this is image 5 and 6 of the 7. Sinus Asperitatis is the top this image just barely overlaps with the bottom of Image 1 above.

Image 4, Sinus Asperitatis, Theophilus and Western Mare Nectaris, *Paul Walker, Middlebury, Vermont, USA. 2023 October 04 08:06 UT, colongitude 146.8º. 10 inch f/5.6 Newtonian reflector telescope, 5,100 mm efl, Canon T7i camera.*

The most prominent feature in Sinus Asperitatis and known to many is Torricelli a good-sized pear-shaped double crater. In images taken with a higher sun it looks like the floor of the smaller end is higher than that of the larger end. However, checking in with LROC QuickMap shows that is not true (see QuickMap Image 5). In particular, note the position of the vertical red line on the graph and the corresponding crosshair on the crater. It appears to me that the width and angle of the slump is consistent with a near simultaneous double asteroid strike. With the larger asteroid pushing material to the left and the smaller one pulverizing additional material on the left with it all flowing toward the larger crater. The ghost crater which Torricelli is in, and is labeled Torricelli R on the LROC QuickMap, is seen well here.

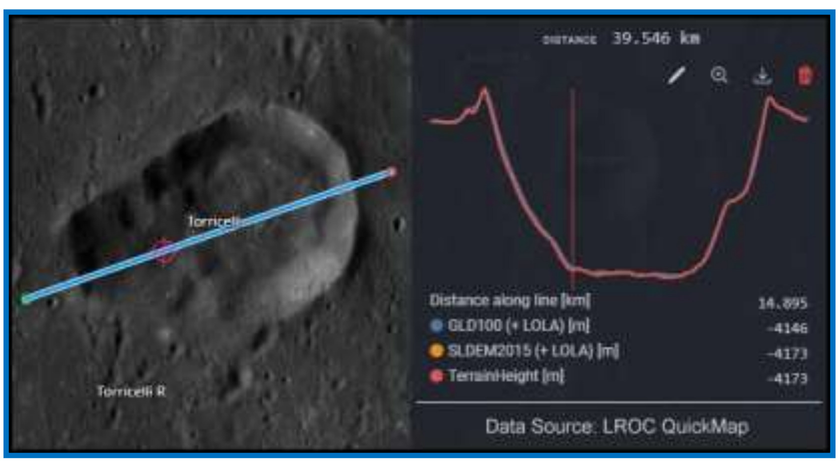


Image 5, Torricelli, *LROC.*

Moving our gaze, a little farther south we see the debris blanket from Theophilus with its many strings of secondary craters. The 2 highest peaks in the center, 2800 m (9200 ft) and 2400 m (7900 ft), are casting nice sharp pointy shadows. Extensive terracing is visible on the east (right) slope of the rim with a more jumbled look on the north and south slopes. Can't see the west wall at all but space craft images show that it is terraced but looks a lot different than the East wall with a large diagonal gash through the slumped material in the south half and a 7 km crater in the north.

More of Theophilus' debris field and secondary craters can be seen on its southeast flank. Within that debris is Rima Beaumont (as labeled on LAC charts) but I seem to remember seeing it Astronomy magazine with a different name, maybe Rima Nectaris. Regardless, it looks more like a wrinkle ridge than a rille.

The Western half of Mare Nectaris is the large relatively smooth semi-circular area on right side half way up. Some low wrinkle ridges are visible. I can't tell whether some of the bumps are domes or just craters. Belmont, half in shadow, is just off the south end of Rima Beaumont. Fracastorius to the lower right of that, is the large crater completely in shadow.

Mare Frigoris, Lacus Mortis and Lacus Somniorum (Image 6)

Though this the last of the areas I imaged on morning of October 4th it is the most northerly image. It is not a mosaic.

Starting at the bottom of this image is a bit of the northeast corner of Mare Tranquillitatis. Depending on what's considered the northern extent of Dorsa Smirnov, the top end of it may be visible. Just above this is the western end of Lacus Somniorum with some wrinkle ridges and a prominent rille of the Rimae Daniell complex on the right. Other Daniell rilles can be seen on the left side of Lacus Somniorum. There are also what look like several lunar domes in the northern part of Somniorum among many non-volcanic hills.

Moving up is Lacus Mortis with Burg forming a big off-center hole in it. If Mortis did not have the Lake designation it surely would be a great example of a fractured floor crater. I would not be surprised to find out that it is counted as one. The rilles in it are Rimae Burg.

A small piece of Mare Frigoris sits at the top of the image, the east end of which is about 140 km (87 mi) outside the right side of image. This part has a nice array of polygonal wrinkle ridges. I don't see that any of them have official names.

__Image 6, Mare Frigoris, Lacus Mortis and Lacus Somniorum,__ Paul Walker, Middlebury, Vermont, USA. 2023 October 04 08:17 UT, colongitude 146.9º. 10 inch f/5.6 Newtonian reflector telescope, 5,100 mm efl, Canon T7i camera.

Lunar Topographic Studies
A Good Morning for Imaging and Viewing

Dorsum Zirkel
Alberto Anunziato

Dorsum Zirkel is a wrinkle ridge that in IMAGE 1 runs from south to north, with a slight inclination from east to west, from the Lambert crater, in the central area of Mare Imbrium (Lambert appears in the upper left as a circle, without drawing). The two topographic components of the wrinkle ridges are clearly noticeable: the arch (which we see in a lighter gray) and the irregular and narrow height at the top (crest). The crest was shining brightly at the time of observation, so we depicted it in white, and it migrates from the west edge to the east edge of the arch and then migrates back to the west edge. Apparently, the height of the crest is much greater at the northern end, due to the volume of shadow it casts. To the west there are two independent segments, a small one in the center and further north a very prominent and bright one. In the central part of the arch, where the crest migrates from west to east, there appears to be a secondary crest that would run along the west margin (where the main crest runs along the east margin), which projects shadow to the west but not perceived as bright.

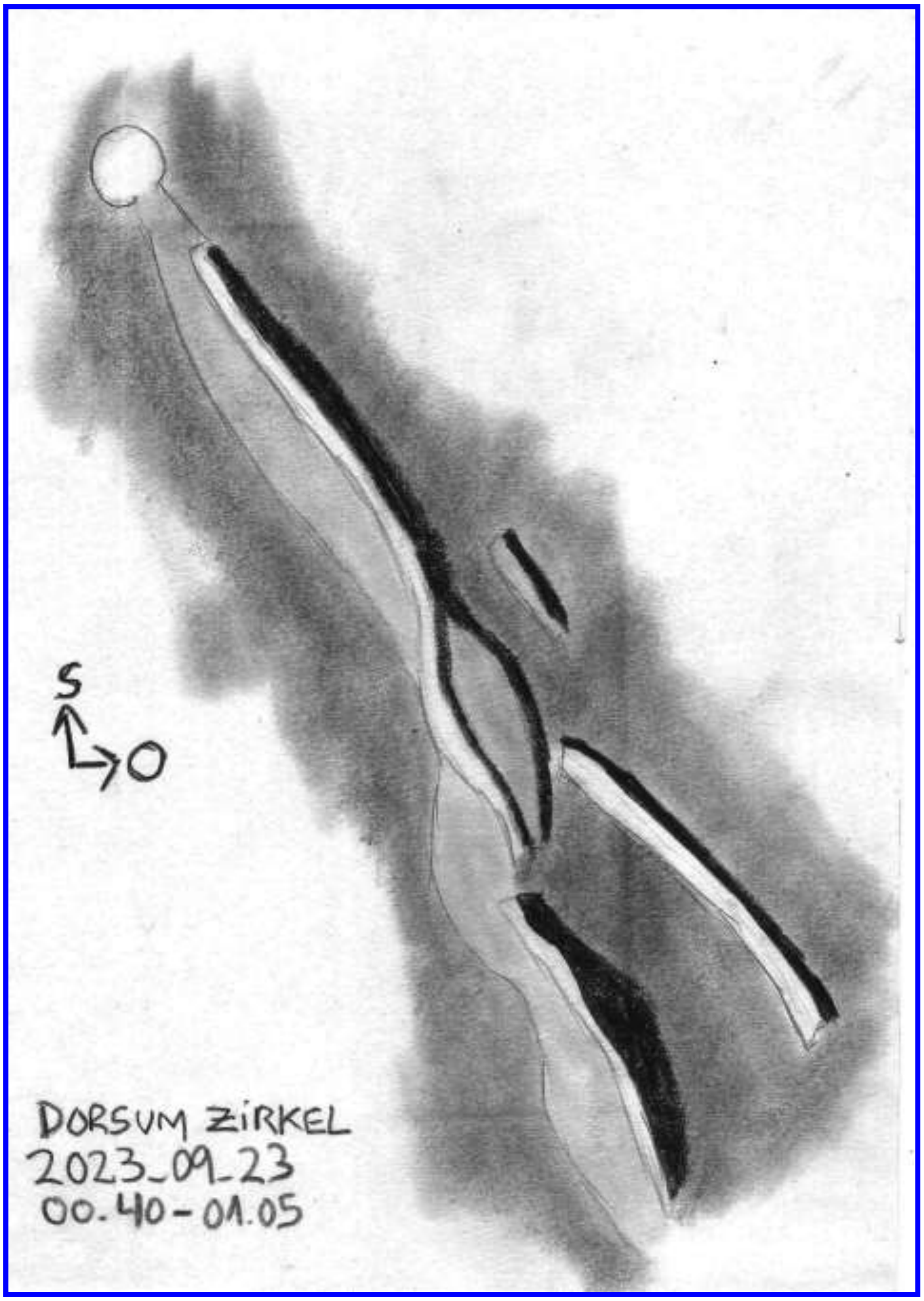


Image 1, Dorsum Zirkel, *Alberto Anunziato, Paraná, Argentina. 2023 September 23 00:40-01:05 UT. Meade 105 EX Maksutov-Cassegrain telescope, 154x.*

Lunar Topographic Studies
Dorsum Zirkel

After the drawing was made, from the sketch drawn behind the eyepiece in my observation notebook, I tried to find an image of Dorsum Zirkel that would allow me to compare it with my observation. As almost always, I found the most detailed photographic image of our wrinkle ridge in the Photographic Lunar Atlas for Moon Observers by Kwok C. Pau, in whose Volume 2 (page 12) we find an image of the area around Lambert, of the that I extracted the detail that is IMAGE 2, in which we see that the west shadow in the central area, opposite to the crest on the east margin, corresponds to the margin of the arch, there is no crest. In reality, the shadow is due to a difference in height between the edge of the arch and the surface of Mare Imbrium. On other occasions I have observed shadows that are not adjacent to brightness on the margin of a wrinkle ridge, it is probably the third topographic element of some wrinkle ridges, it is the first element in a text by Aubele (Morphological components and patterns in wrinkle ridges: kinematic implications, 1989, MEVTV Workshop on Tectonic Features on Mars, pages 13-15): "1) a broad linear rise, which may not always be present or may be visible only under low illumination angles; 2) an arch, which may be up to 200m high and 7 km wide; and 3) a crenulated ridge which may be up to 100 m high and 1,5 km wide and may be central or marginal to the position of the arch". The "broad linear rise" could be evident in the central zone of Dorsum Zirkel.

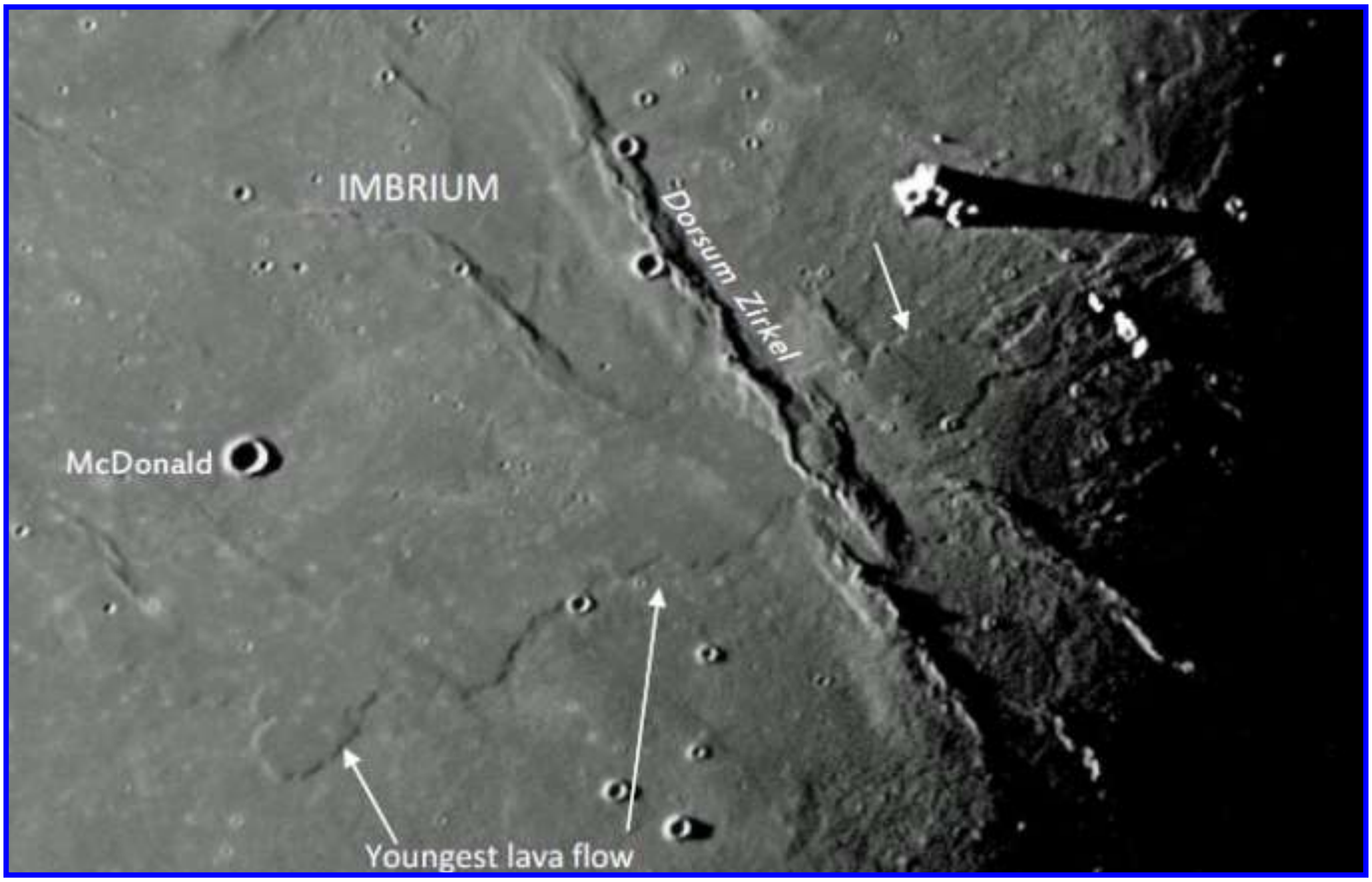


Image 2 Dorsum Zirkel *from Photographic Lunar Atlas for Moon Observers by Kwok C. Pau, Volume 2 (page 12)*

Focus-On: Hiking In the Moon: Dorsa Smirnov

Alberto Anunziato

The wrinkle ridges are a strangely beautiful selenographic feature. They are truly impressive when we visit "the land of long shadows" or, to put it less poetically, the areas of the terminator in which the brights and shadows appear sharply defined, as in an expressionist film noir from the 1950s: the Maria. We will turn, once again in this series of articles for the Focus On section, to an old book (The Moon, by Thomas Elger, from 1895) but valuable for the visual observer (it is the fruit of the heroic age of visual observation) because its descriptions are very useful, even to compete with the English author: can we see everything that Elger saw? And as a good visual observer, Elger has a predilection for maria: "Most observers will agree with Schmidt, that observations and drawings of objects on the somber depressed plains of the moon are easier and pleasanter to make than on the dazzling highlands, and that the lunar "sea" is to the working selenographer like an oasis in the desert to the traveler a relief in this case, however, not to an exhausted body, but to a weary eye". And in that landscape some tiny mountain ranges stand out in the light of the rising sun, the wrinkle ridges (or dorsa, singular: dorsum), which, quoting Elger once again: "under a rising sun (...) they are strikingly beautiful in a good telescope, reminding one of the ripple-marks left by the tide on a soft sandy beach. Like most other objects of their class, they are very evanescent, gradually disappearing as the sun rises higher in the lunar firmament, and ultimately leaving nothing to indicate their presence beyond here and there a ghostly streak or vein of a somewhat lighter hue than that of the neighboring surface".

Short is the time in which we can observe the wrinkle ridges during a lunation, so their registration is important, both visually and photographically. But, in addition to their evanescent and transitory beauty, wrinkle ridges are also a tangible reality. While there is no definitive consensus on the cause of the formation of wrinkle ridges on the Moon, there does seem to be at least a provisional consensus: They are compressional features of tectonic origin, wich are the surface result of a tectonic process of compression within the inner crust from loading by basalt fill that generates a blind thrust fault below and a anticline above (Yue).

It is interesting to note that most wrinkle ridges have an orientation north-south with a stress direction east-west, they all formed in a common and continued process, developped in a short period of time, geologically speaking, after the basalt emplacement.

Lunar wrinkle ridges can be distinguished on the basis of their peculiar morphological characteristics: A change in slope contrasting with the surrounding mare, an elevation difference between the mare surface on one side of the wrinkle ridge and the opposite side which is regarded as evidence for the fault beneath the ridge.

Even with small telescopes we can observe that wrinkle ridges are a system of related individual components, segmented features along a general sinous trend (Aubele). Each of these segments, individual components of a wrinkle ridge, has a topography of: "a broad, bulbous swelling and a narrow ridge crest that commonly occurs along one side of the broad swell". (Wood, 2003). Z. Yue name the two components: "a gently sloping, broad arch and a sharper, but more irregular ridge".

We are going to see that, although there are two structural components of the topography of a wrinkle ridge, it is a "complex structures with primary, secondary, and tertiary ridges" (Thompson), in some segments, the complexity of these low and narrow elevations is notable, which have an average width of 3.70 km and an average height of 300 meters (according to global mapping by Z. Yue et al.).

Wrinkle ridges do not have much prominence in photographic atlases and generally few details are observed in their images, with the great exception of the Photographic Lunar Atlas for Moon Observers by Kwok C. Pau. Observing visually it is necessary to concentrate the vision a little so that the details begin to emerge while the overall beauty begins to become more detailed.

Readers of our magazine will remember that there was a Focus On that focused on wrinkle ridges a few years ago and also the selenographic feature that we are dealing with was included in one of the Focus Ons dedicated to the Lunar 100 list, in the November 2020 issue, since it is the only wrinkle ridge that has a place in Charles Wood's famous lunar list, occupying place 33, we refer to the Serpentine Ridge. And the best definition of our objective is, precisely, by Charles Wood (2004): "One of the most wondrous lunar sights can be observed when the Moon is 6 days old. Paralleling the eastern shore of Mare Serenitatis is the snakelike Serpentine Ridge. This fine name has been around since Schroeter (1790s)". It is really a beauty, and a very complex one. One clarification: Serpentine Ridge encompasses Dorsa Smirnov and Dorsum Lister: "the IAU, in their woeful ignorance of history and selenology, gave different parts of this obvious single structure two unnecessary names: Dorsum Smirnov and Dorsum Lister" (Wood, 2004). If we look at the images that our observers sent, it is curious that the ridges were observed for the first time in the early 1890s (according to Yue) or at the latest in the late 18th century by Schröter (according to Elger) and today we can observe what which, for example, Hevelius failed to observe. Wrinkle ridges or dorsa? Those of us who speak Spanish use the official IAU term, dorsum (plural dorsa), but I don't dare use it in English, because I always remember what Wood says: (2003): "During the "scientification" of the Moon when it passed from amateurs to professional scientist, the more dignified term "mare ridge" was invented. In an early outbreak of political correctness in the 1970's the features were renamed with the sharklike term dorsa, a term that only pedants use". Therefore, we use the term wrinkle ridge.

Image 1, Sulpicius Gallus, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 May 14 02:32 UT. Meade 10 inch LX200 Schmidt-Cassegrain telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera.*

Mare Serenitatis is one of the most prominent maria with wrinkle ridges, which we can see in IMAGES 1 TO 4. In these images it is not so clearly perceived how spectacularly more noticeable Serpentine Ridge is compared to the other ridges, as seen in the IMAGE 5 to 8. It is interesting to illustrate these images with the description of Peter Grego: "Under low angle of illumination, Mare Serenitatis displays an intricate system of wrinkle ridges that snake their way around the sea, keeping roughly parallel to its border. The most prominent of these wrinkle ridges is Dorsa Smirnov, an impressive braided "rope" of wrinkles, in places 15 km wide, about 100 km from the mare border Dorsa Smirnov is around 200 km long, and can easily be glimpsed through a small telescope when it is near the terminator. It originates at a point around 50 km west of Posidonius and flows south through the small crater Very (5 km), south of which the ridge bends and narrows. Another ridge rises again a little further south, where it is called the Dorsa Lister, a system of ridges around 300 km long. Dorsa Lister curves parallel to the southern mare border, where it is encroached upon at right angles by a number of narrower ridges". Could it be that Serpentine Ridge is part of one of the supposed, and quite hypothetical, rings of the Mare Serenitatis Basin? It is a possibility that Charles Wood refers to in The Modern Moon.

Image 2, Dorsa Smirnov, *Anthony Harding, Northeast Indiana, USA. 2023 September 05 07:05 UT, colongitude 152.453º. GSO 6 inch f/6 Newtonian reflector telescope, 2.5x Power Mate, ZWO ASI290MM/S camera. Seeing 4/10, transparency 3/6.* Anthony adds: "This capture is a close-up of Dorsa Smirnov. The exposure and processing were heavy to bring out the details of the Dorsa. Of course, the surrounding highlands are therefore overexposed. A lot of intricate detail can be easily recognized in the Dorsa, including height and slope variations along its length. Posidonius is the large crater sitting on the terminator at the top."

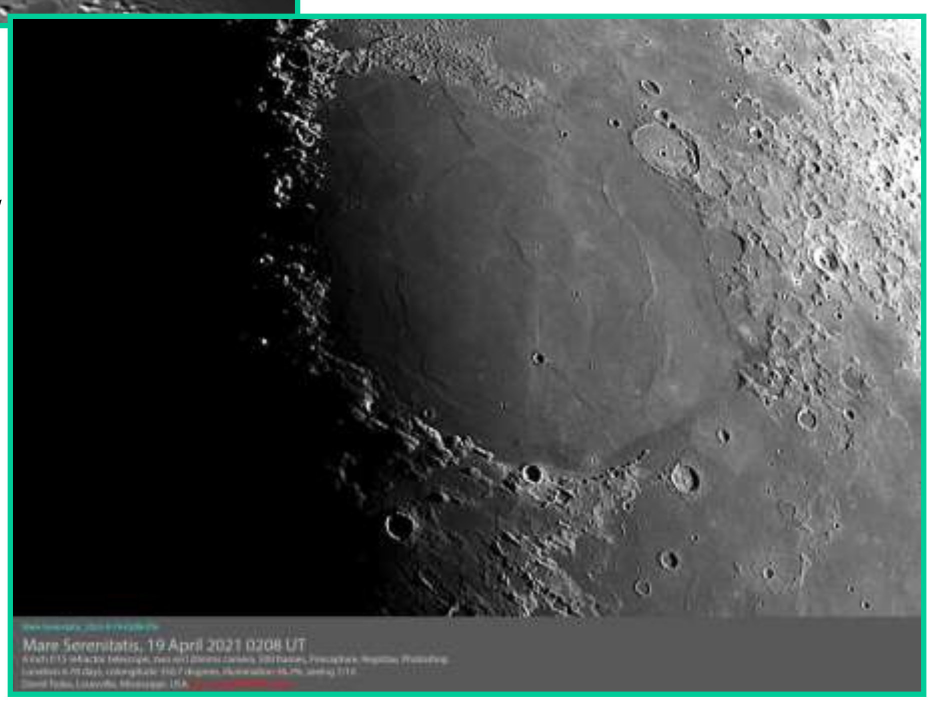
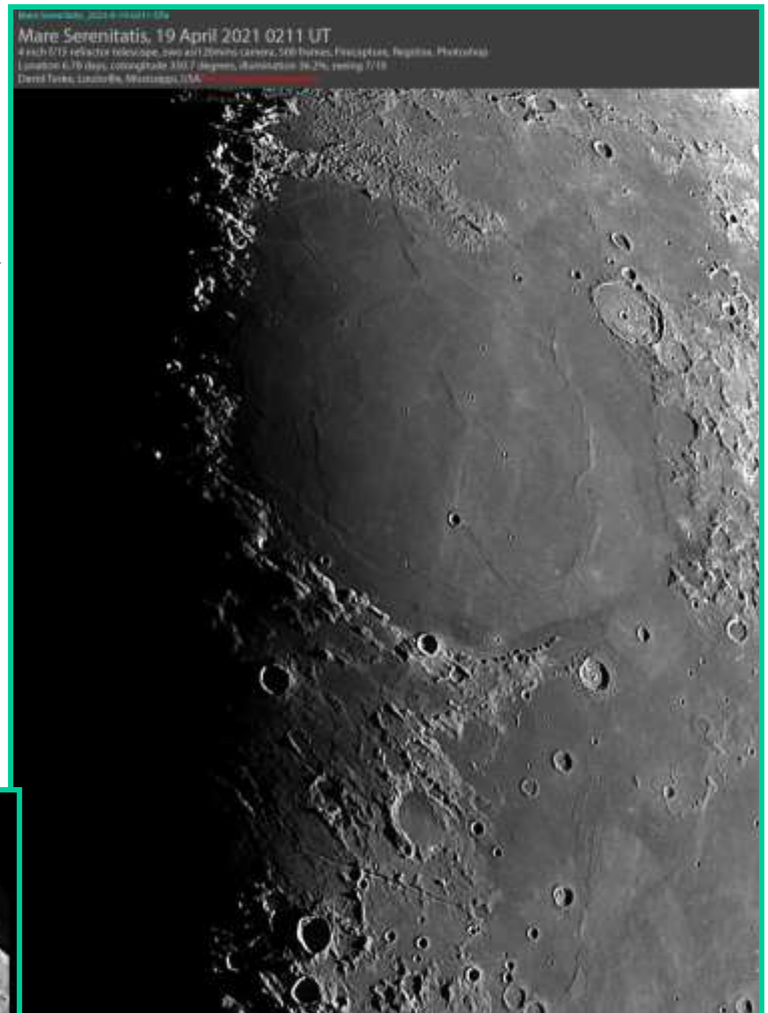


Image 3, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2021 April 19 02:08 UT, colongitude 350.7º. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 7/10.*

__Image 4, Mare Serenitatis,__ David Teske, Louisville, Mississippi, USA. 2021 April 19 02:11 UT, colongitude 350.7°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 7/10.



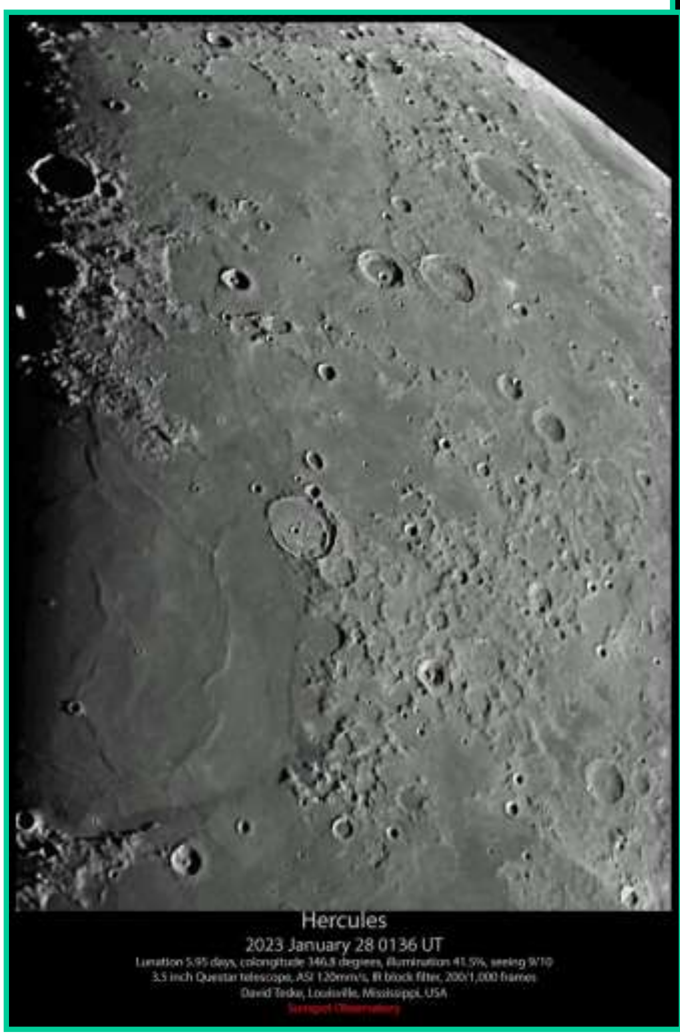


__Image 5, Hercules,__ David Teske, Louisville, Mississippi, USA. 2023 January 28 01:36 UT, colongitude 346.8°. 3.5 inch Maksutov-Cassegrain telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 9/10.

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Image 6, Lacus Mortis, *David Teske, Louisville, Mississippi, USA. 2022 September 15 08:39 UT, colongitude 143.6º. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 8/10.*

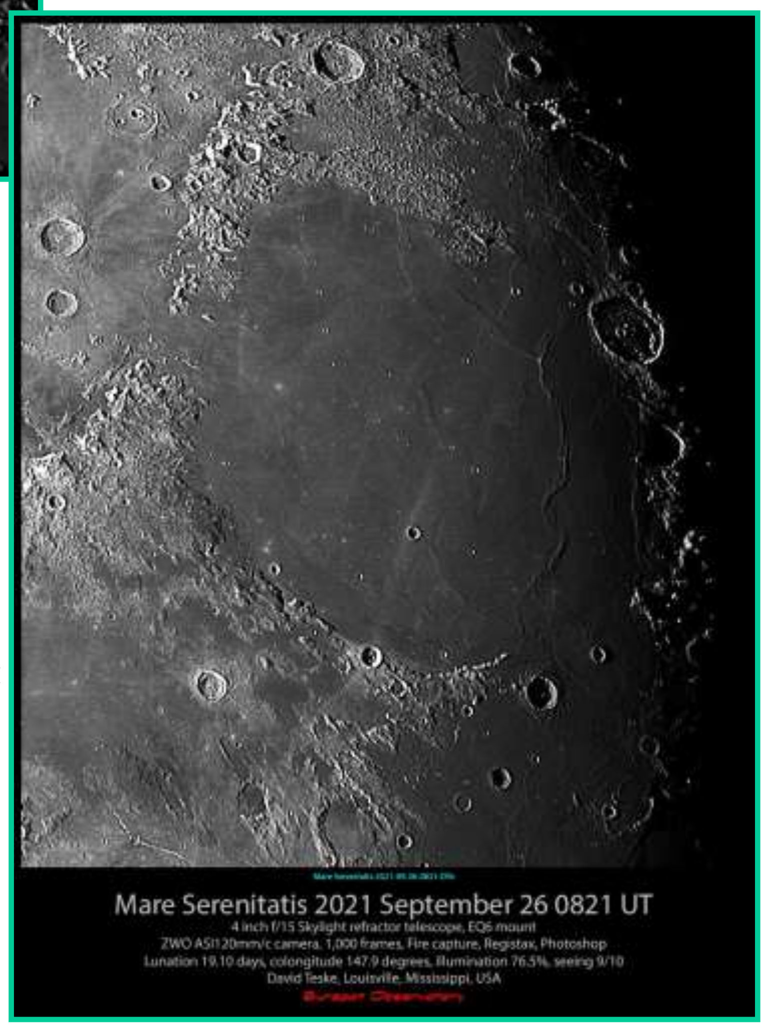


Image 7, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2021 September 26 08:21 UT, colongitude 147.9º. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 9/10.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Image 8, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2021 May 30 09:02 UT, colongitude 134.9°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 6-7/10.*

In IMAGE 9 we can see Elger's accurate description, when he talks about the “winding course across the Mare”: “The Mare Serenitatis and the Mare Imbrium, in the northern hemisphere, are also remarkable for the number of these peculiar features. They are very plentifully distributed round the margin and in other parts of the former, which includes besides one of the longest and loftiest on the moon's visible surface the great serpentine ridge, first drawn and described nearly a hundred years ago by the famous selenographer, Schröter of Lilienthal. Originating at a little crater under the northeast wall of great ring-plain Posidonius, it follows a winding course across the Mare toward the south, throwing out many minor branches, and ultimately dies out under a great rocky promontory, the Promontory Archerusia, at the western termination of the Haemus range. A comparatively low power serves to show the curious structural character of this immense ridge, which appears to consist of a number of corrugations and folds massed together, rising in places, according to Neison, to a height of 700 feet and more.”

Image 9, Dorsa Smirnov, *Anthony Harding, Northeast Indiana, USA. 2023 September 05 07:05 UT, colongitude 152.453°. GSO 6 inch f/6 Newtonian reflector telescope, 2.5x Power Mate, ZWO ASI290MM/S camera. Seeing 4/10, transparency 3/6.* Anthony adds: “This capture is a close-up of Dorsa Smirnov. The exposure and processing were heavy to bring out the details of the Dorsa. Of course, the surrounding highlands are therefore overexposed. A lot of intricate detail can be easily recognized in the Dorsa, including height and slope variations along its length. Posidonius is the large crater sitting on the terminator at the top.”

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

More precise is the description of Pau: “Serpentine Ridge is popularly known to all amateur lunar observers. It looks like a snake crawling slowly towards its prey along the eastern border of Mare Serenitatis. This ridge is made up of two components. Northern portion is Dorsa Smirnov, which is about 200 km long and forks into two branches at northern end. Southern component is Dorsa Lister, which is about 300 km long and curves its way along the southern border of the mare. It is linked with a ridge arising at crater Dawes and Dorsa Nicol. A braided structure is very obvious in these two dorsa”, which we can see more clearly in the IMAGE 10

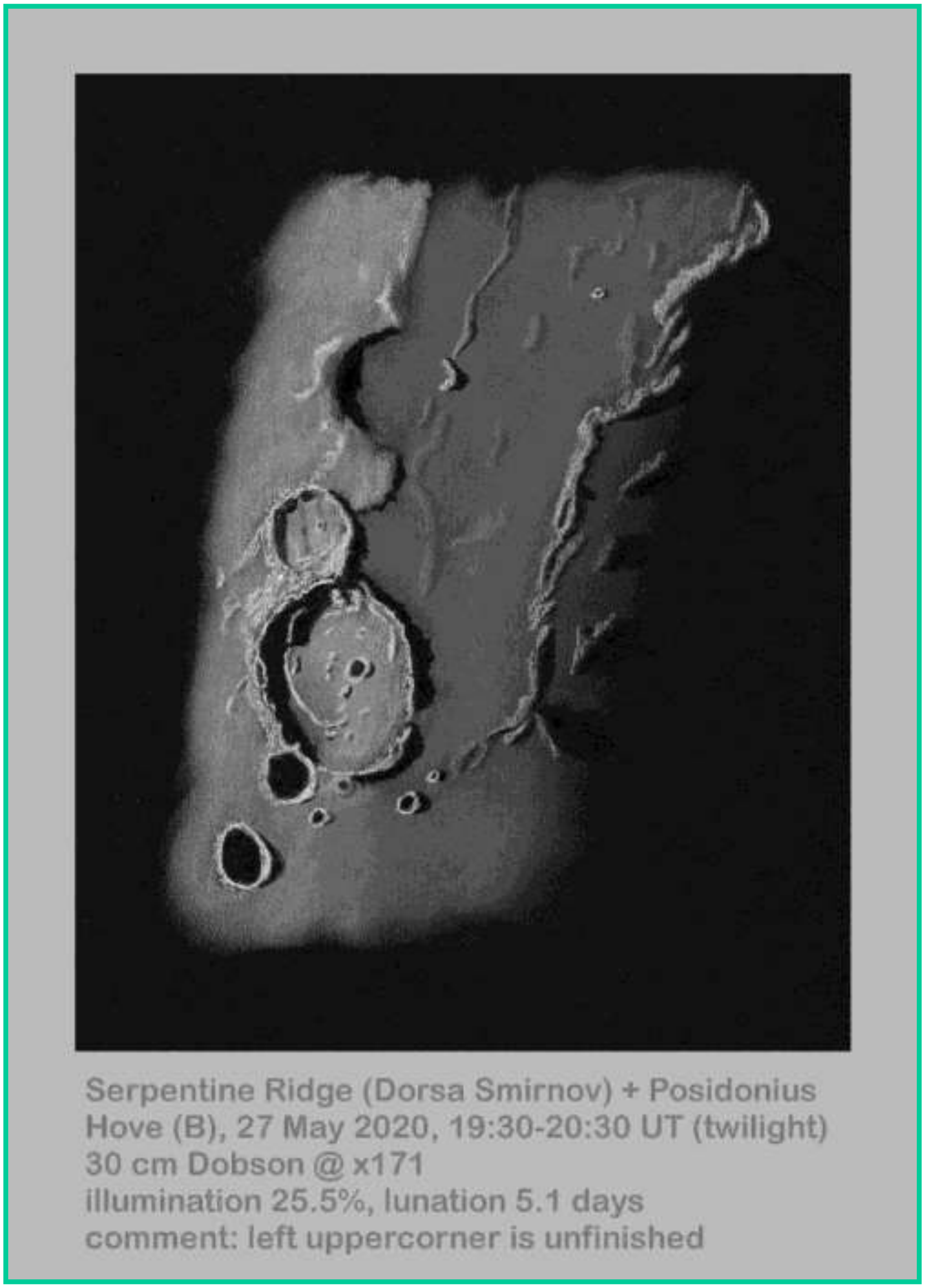


Image 10, Dorsa Smirnov and Posidonius, *Jef De Wit, Hove, Belgium. 2020 May 27 19:30-20:30 UT. 30 cm Dobsonian reflector, 171 x.*

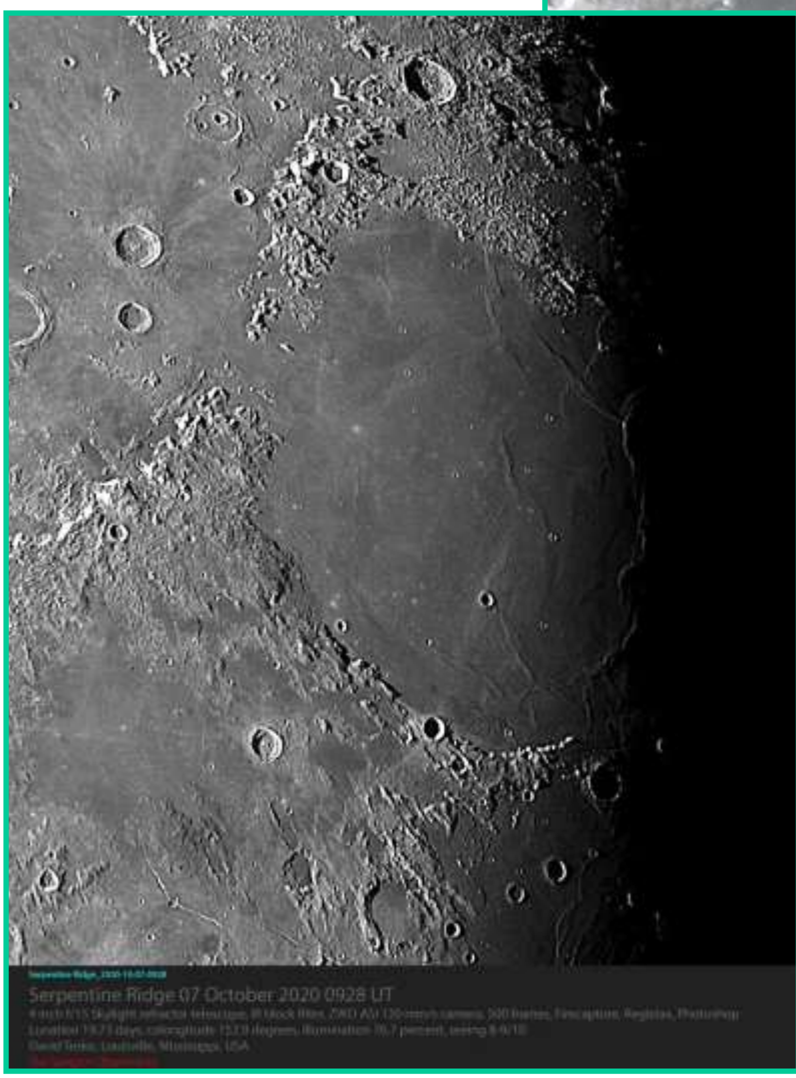
When is the best time to observe Dorsa Smirnov? “These two ridges stand out best about the time of first quarter or about five days after full moon, because they generally parallel the terminator at those phases. Their contrast in shadows and elevations above the floor of the mare are best viewed when the terminator is only a few degrees to the east or west of the ridges” (Garfinkle).

With frontal illumination, like all wrinkle ridges, it becomes practically impossible to distinguish them, as we see in IMAGES 11 to 13. However, our ridge is so prominent that we can also distinguish bright areas, such as the area in which Posidonius Y is found and the last segment of the Dorsa Smirnov to the south, as we will see later, the brightness near Posidonius Y could be due to the fresh materials ejected in the impact of that crater, while clearly the southernmost segment is the highest of the set.

Image 11, Dorsa Smirnov, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:37 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, IR Focus On filter, ZWO ASI120mm/s camera.*

Image 12, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2023 March 30 03:03 UT, colongitude 6.7º. Takahashi FOA60Q refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 8/10.*

Image 13, Dorsa Smirnov, *Francisco Alsina Cardinalli, Oro Verde, Argentina, AEA. 2016 March 28 04:45 UT. Celestron 11 inch Schmidt-Cassegrain telescope, Canon EOS Digital Rebel XS camera.*



With oblique lighting it is a fascinating spectacle, as we can see in IMAGE 14, in which the bright areas increase with respect to the previous ones. Posidonius Y is still the brightest point? With the sun higher over the Serpentine Ridge (IMAGE 15) the shadows and the complex structure of overlapping segments appear in all their splendor.

Image 14, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2020 October 07 09:48 UT, colongitude 152.9º. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 8-9/10.*

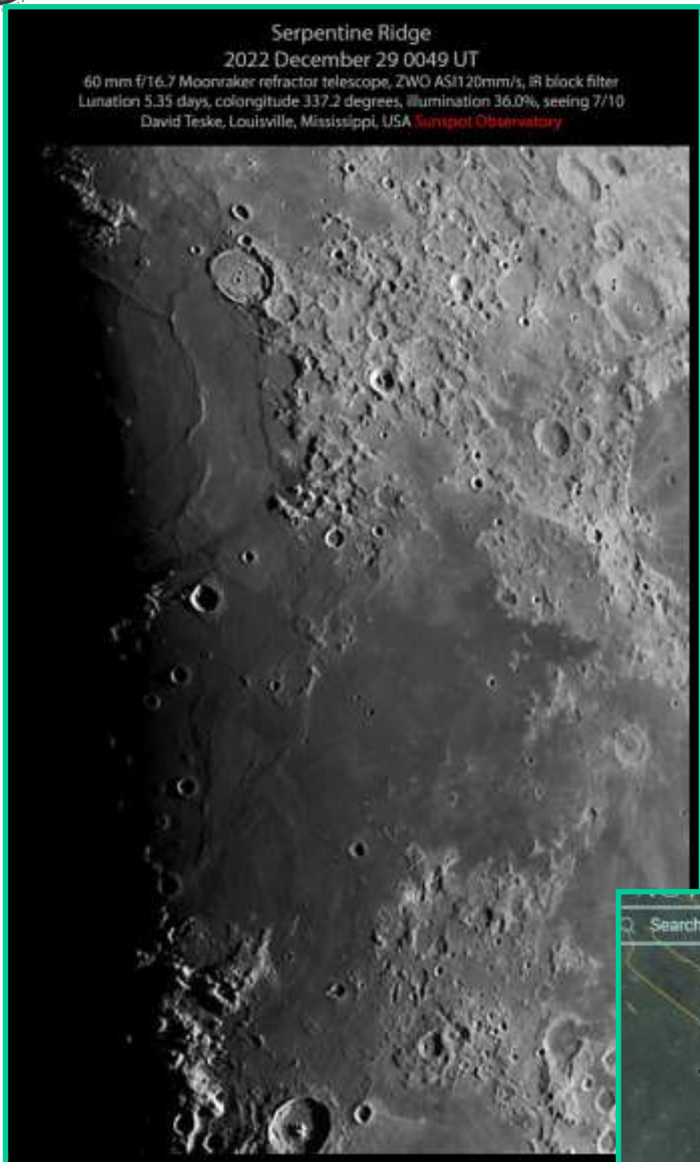


Image 15, Mare Serenitatis, *David Teske, Louisville, Mississippi, USA. 2022 December 29 00:49 UT, colongitude 337.2º. 60 mm f/16.7 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 7/10.*

We are going to take a hike along the Serpentine Ridge, which is nothing more than a series of independent segments like all wrinkle ridges. In IMAGE 16 we gave a number to each of the segments recognized as wrinkle ridges on the Lunar Reconnaissance Orbiter Quickmap Map of Wrinkle Ridges. Strictly speaking, I don't know if segments 1, 2, 3, 6 and 7, located to the west, belong to the Serpentine Ridge, but we will analyze them as if they do. In IMAGE 17 we can clearly see the segments that we marked, it is interesting to compare and keep this image in mind to reference the different segments.

Image 16, Dorsa Smirnov, *LROC QuickMap*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

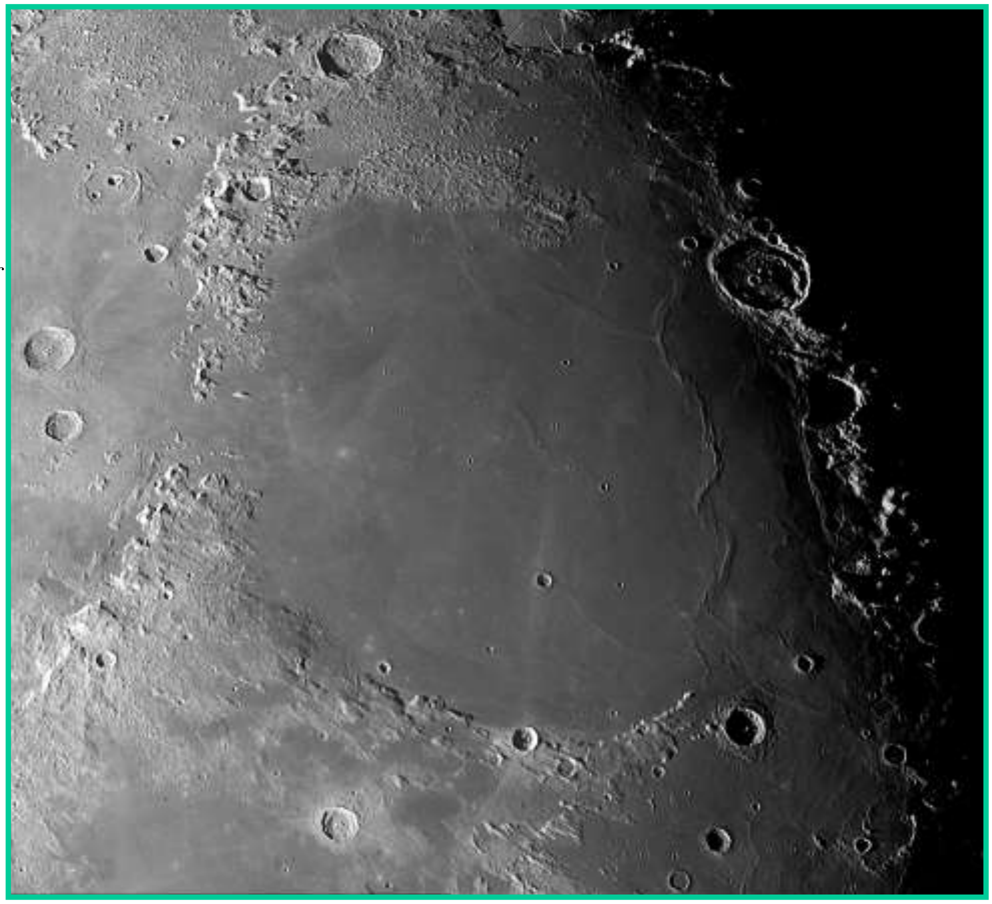


Image 17, Dorsa Smirnov, *Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope*

We start with segments 1 to 3, which seem to form a group (IMAGE 18, in which they are perceived as small bright spots). Segment 1 (IMAGE 19) has its steep slope to the west, the same as segment 2 (IMAGE 20), which has a much steeper topography, which is repeated in segment 3 (IMAGE 21), which even seems to join with segment 4. Segments 1 and 3 are steeper, which is indirectly confirmed in IMAGE 20, segment 2, with gentle slopes, is almost not visible. We see a better overall view of these three segments in IMAGE 22 and 23, in which we clearly see segments 4 and 5.

Image 18, Mare Serenitatis, Mare Tranquillitatis and Mare Crisium, *Anthony Harding, Northeast Indiana, USA. 2020 December 20 23:45 UT, colongitude 343.386º. Celestron C6N 6 inch Newtonian reflector telescope, ZWO ASI224MC camera. Seeing 4/10, transparency 3/6. Anthony adds:* "This is an older, cropped wide shot of the east-central portion of the Moon at approximately six days old. Dorsa Smirnov can be seen during morning illumination. This was a general shot, with no particular focus for the capture or processing."

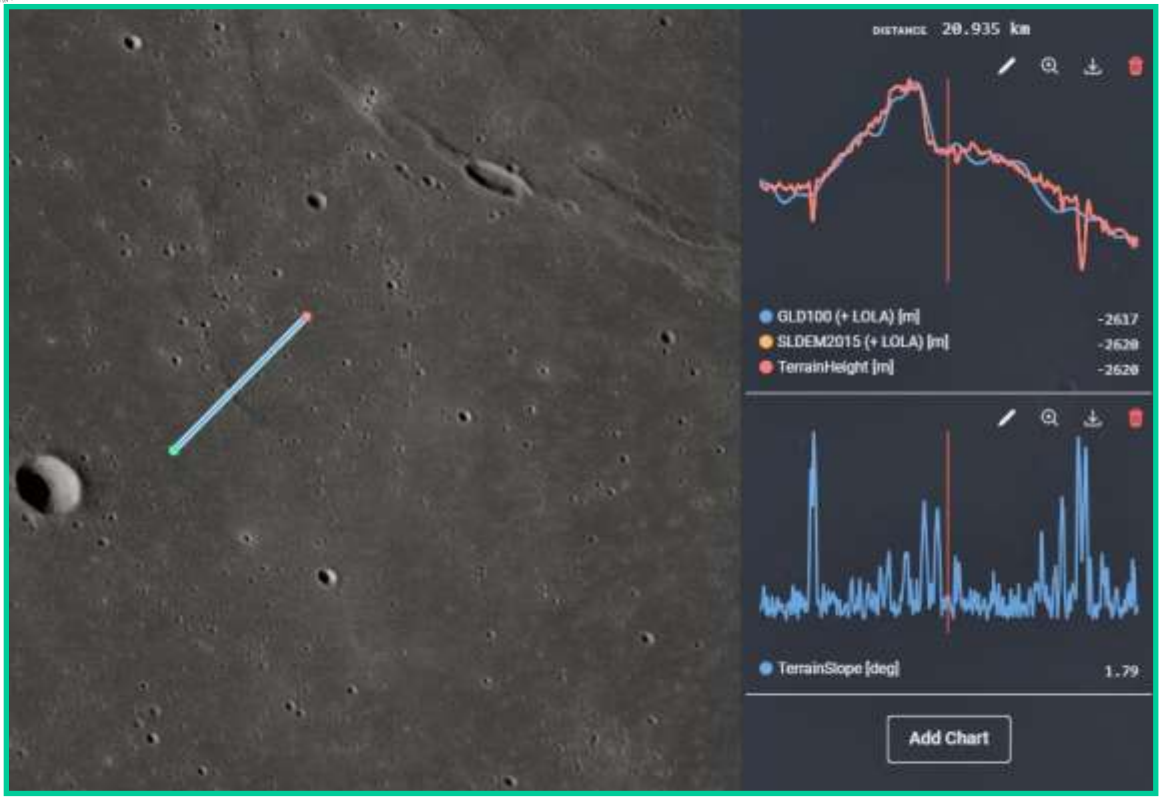
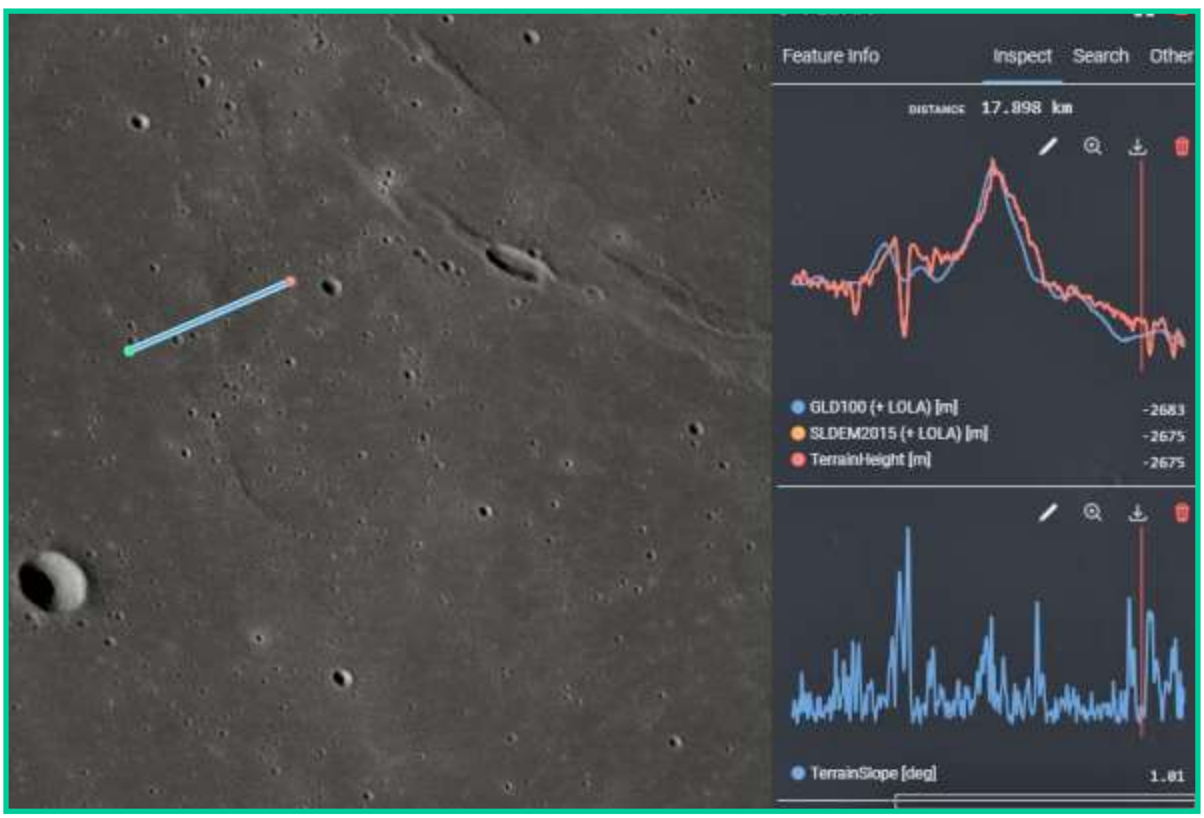


Image 19, Dorsa Smirnov, *LROC QuickMap.*

Image 20, Dorsa Smirnov, *LROC QuickMap.*



FOCUS ON: Hiking In the Moon: Dorsa Smirnov

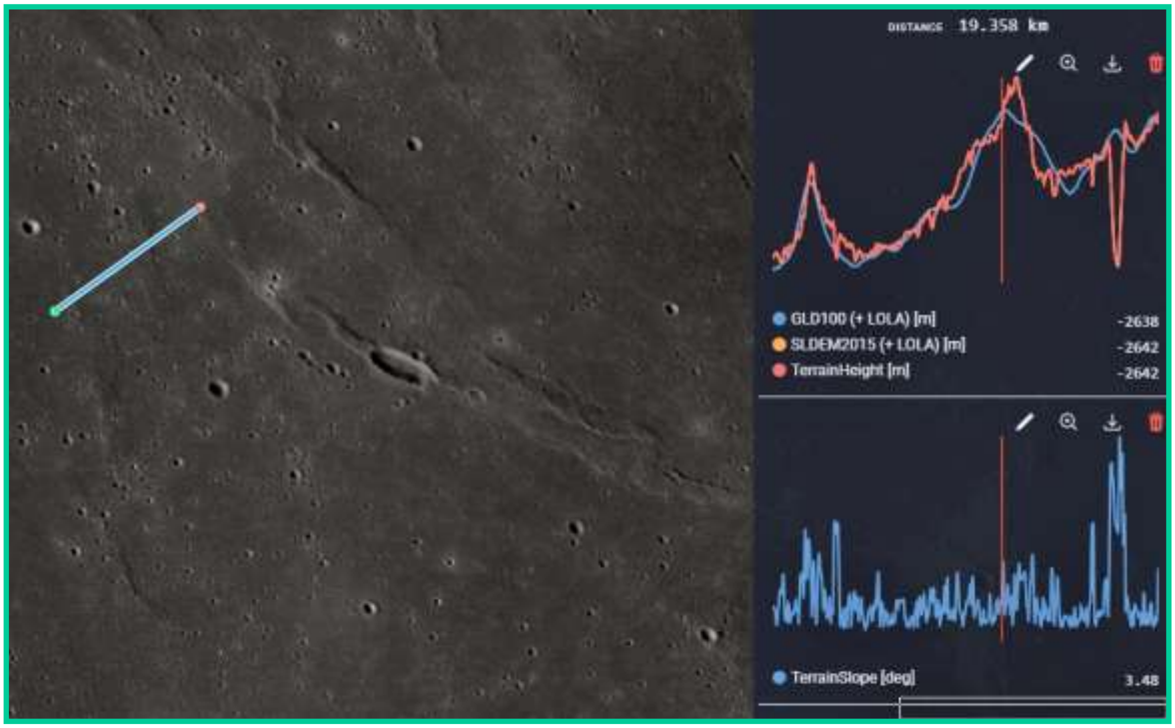


Image 21, Dorsa Smirnov, *LROC QuickMap.*

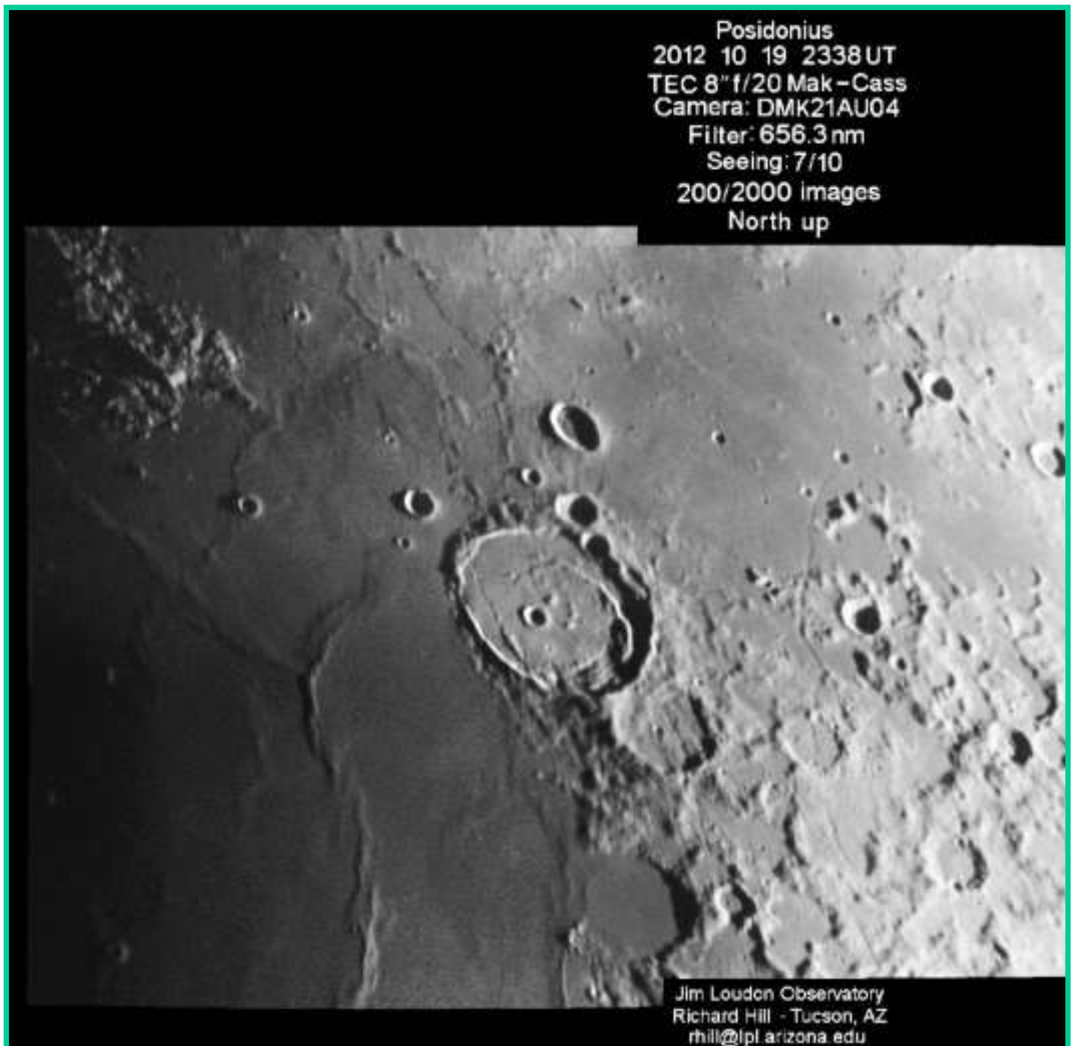


Image 22, Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2012 October 19 23:38 UT. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 656.3 nm filter, DMK21AU04 camera. Seeing 7/10.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

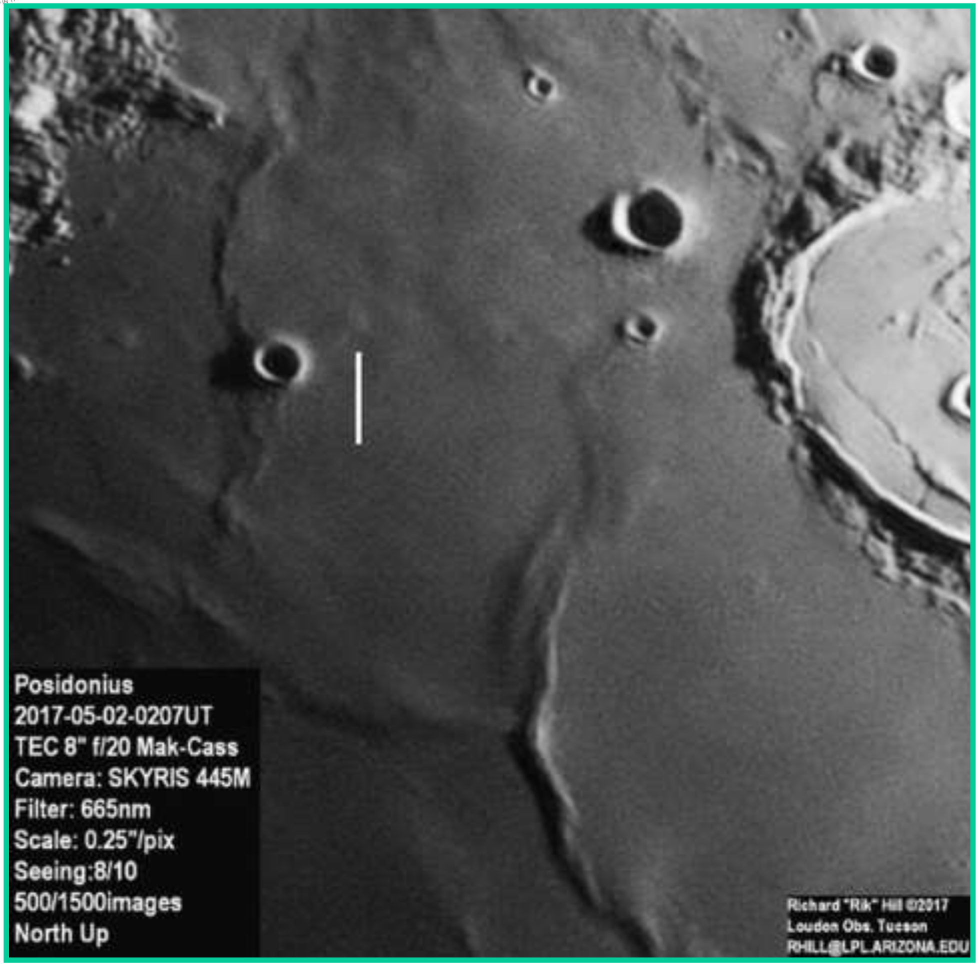


Image 23, Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2017 May 02 02:07 UT. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 445M camera. Seeing 8/10.*

Segments 4 and 5 run east-west, not north-south (and this is a problem for visualization), and are much more prominent than the previous ones. Separating them from segment 6 is for the purpose of being more precise in the description, nothing more, in the end all the segments belong to the same wrinkle ridge, Dorsa Smirnov.

The topography of the western part of segment 4 (IMAGE 24) is truly interesting, because it represents very well the typical structure of a wrinkle ridge: the surface of the mare to the west is much lower than the eastern part (Yue et alt.), the ridge is perceived with extraordinary topographical precision as a height upon a height. If we see IMAGE 25, enlargement of IMAGE 17, we see that the ridge changes from north to south and that the ridge of segment 4 runs first on the north side, then south and then back to the north, and that the ridges closest to the union with segment 5 in the point of union with Posidonius And they are "in echelon", which is not perceived in the LRO Quickmap images. The technology of the probe cameras in lunar orbit has advanced since the Lunar Orbiter probes that Wood refers to in "The Modern Moon", but comparing the degree of detail of Grainger's IMAGE 24 and that of IMAGE 25 of The Lunar Reconnaissance Orbiter, its statements remain accurate: "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" (Wood, 2003). Segment 4 is a little less steep as it approaches Posidonius Y (IMAGE 26).

Image 24, ***Dorsa Smirnov,*** *LROC QuickMap.*

Image 25, Dorsa Smirnov, *Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope. This is a close-up of image 17.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

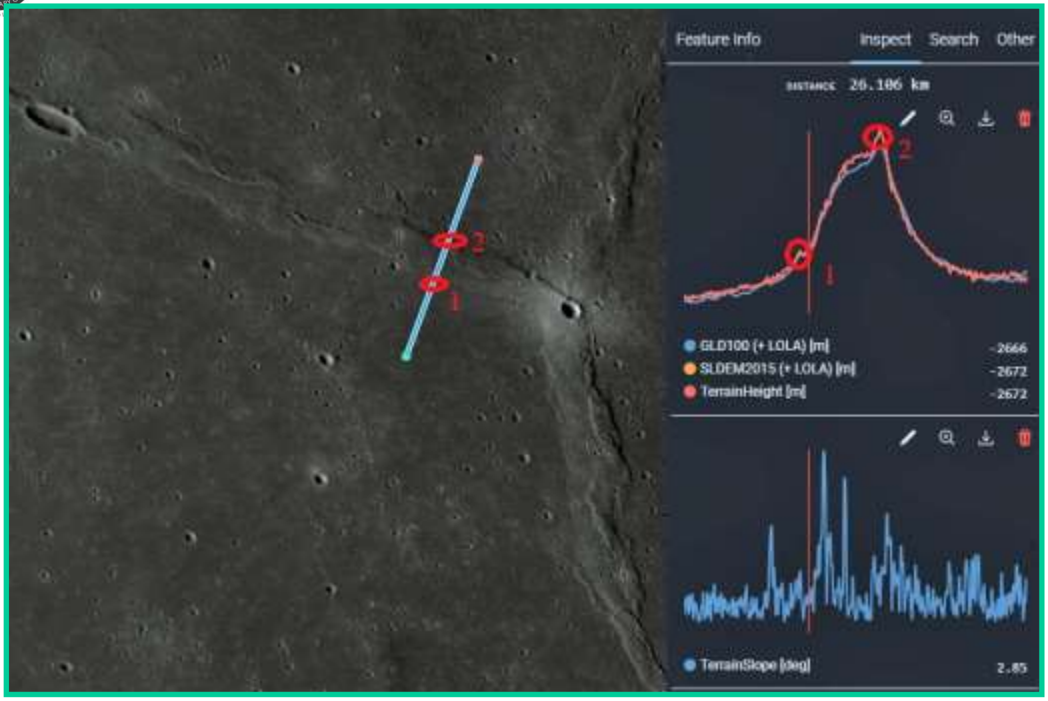


Image 26, Dorsa Smirnov, *LROC QuickMap.*

Segment 5 seems to have a less abrupt relief than segment 4 if we see IMAGE 27, but if we turn to another detail of IMAGE 17 (IMAGE 28), the ridges (upper part of the ridge) are clearly perceived: the highest areas. They shine brighter and cast thicker shadows. In IMAGE 28 we mark with a red arrow a central area in which there appears to be no crest, rather there are two depressions, so we can perceive the shadow as less pronounced (we could say that it is the shadow of the arch without a crest).

Image 27, Dorsa Smirnov, *LROC QuickMap.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

__Image 28, Dorsa Smirnov,__ Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope. This is a close-up of image 17.

Segments 6 and 7 have a steep slope to the west, and do not appear to have a complex relief or be very high (IMAGE 29). Both segments are clearly seen to the left of the main segments in IMAGE 30.

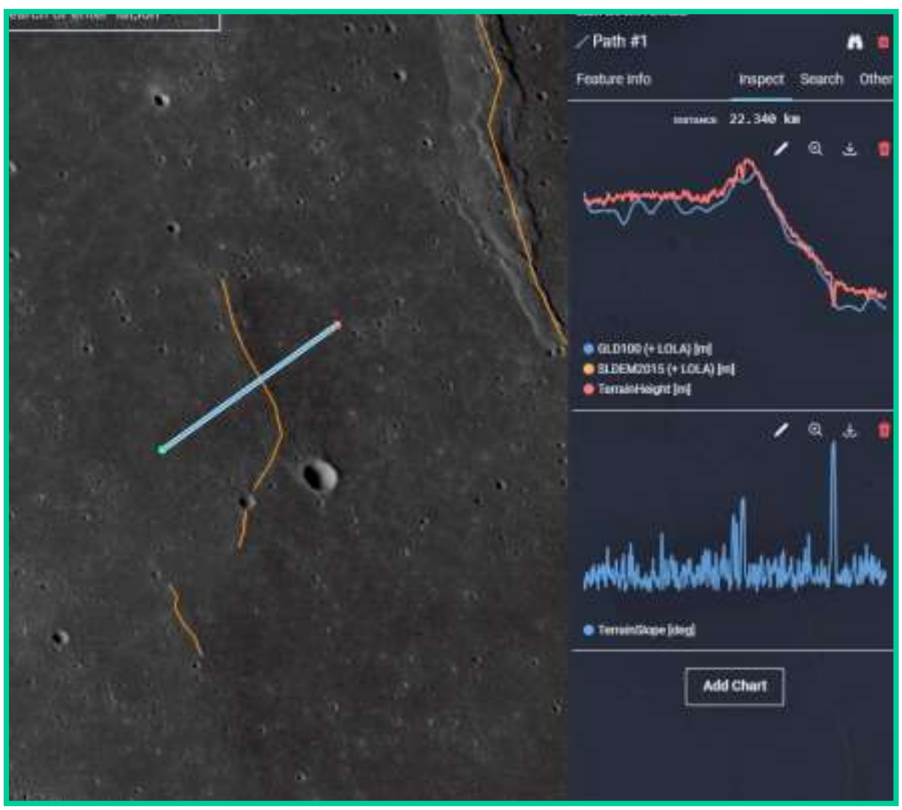


__Image 29, Dorsa Smirnov,__ LROC QuickMap.

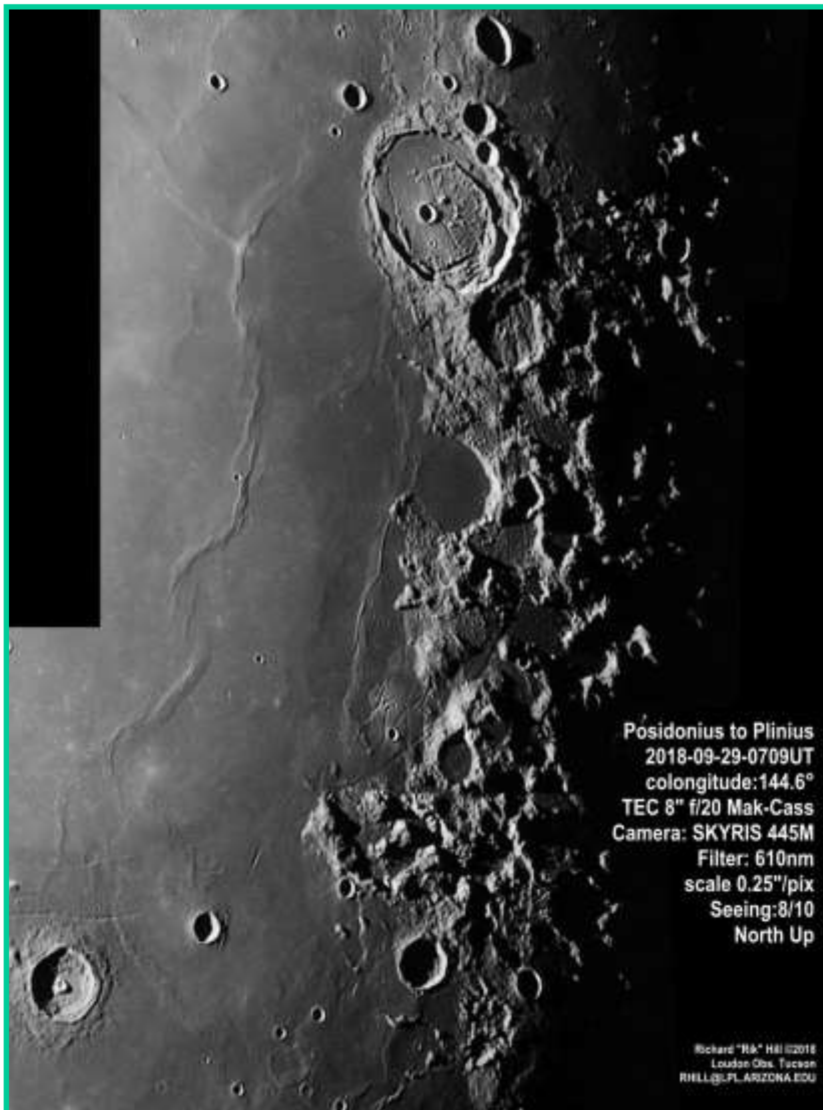


Image 30, Posidonius to Plinius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2018 September 29 07:09 UT, colongitude 144.6º. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 445M camera. Seeing 8/10.*

From the small crater Posidonius Y (2 km in diameter, but very prominent due to its brightness) begins, in our arbitrary division, segment 8, the longest and the most spectacular due to its complex topography. Without a doubt Posidonius Y is a very particular crater, about which Paul Walker makes an exhaustive analysis in the text that accompanies the present. Posidonius Y is a Copernican crater, obviously, since it is later than the ridge in which it impacted and has a very bright ejecta blanket, which makes it very conspicuous. We see it in IMAGE 31. By chance, the impact of Posidonius coincided with the intersection of two segments of Dorsa Smirnov, which previously made astronomers think about the relationship between craters and ridges. "The Moon" by Thomas Elger is very illustrative: "It is suggestive of many of the lunar ridges, in seas and other places, which are generally associated with craters of all sizes. We have examples in many places. We frequently find small craters on the summits of these elevations, but more often on their flanks and near their base. When a dorsum abruptly changes direction, a crater of some prominence usually marks the point, often forming a knot or crossroads with other dorses, which therefore seem to radiate from it as if it were its center."

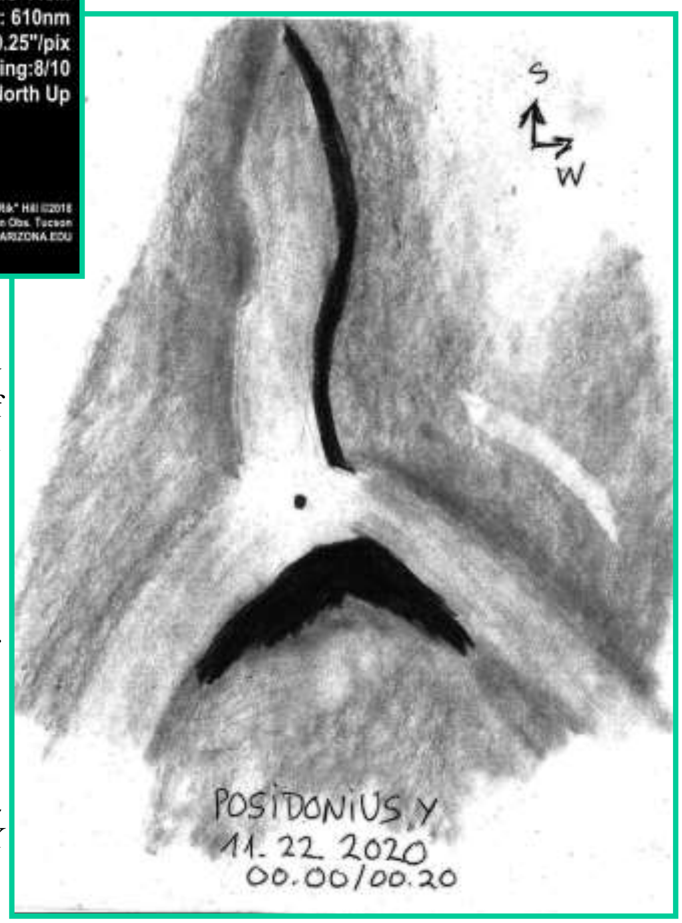
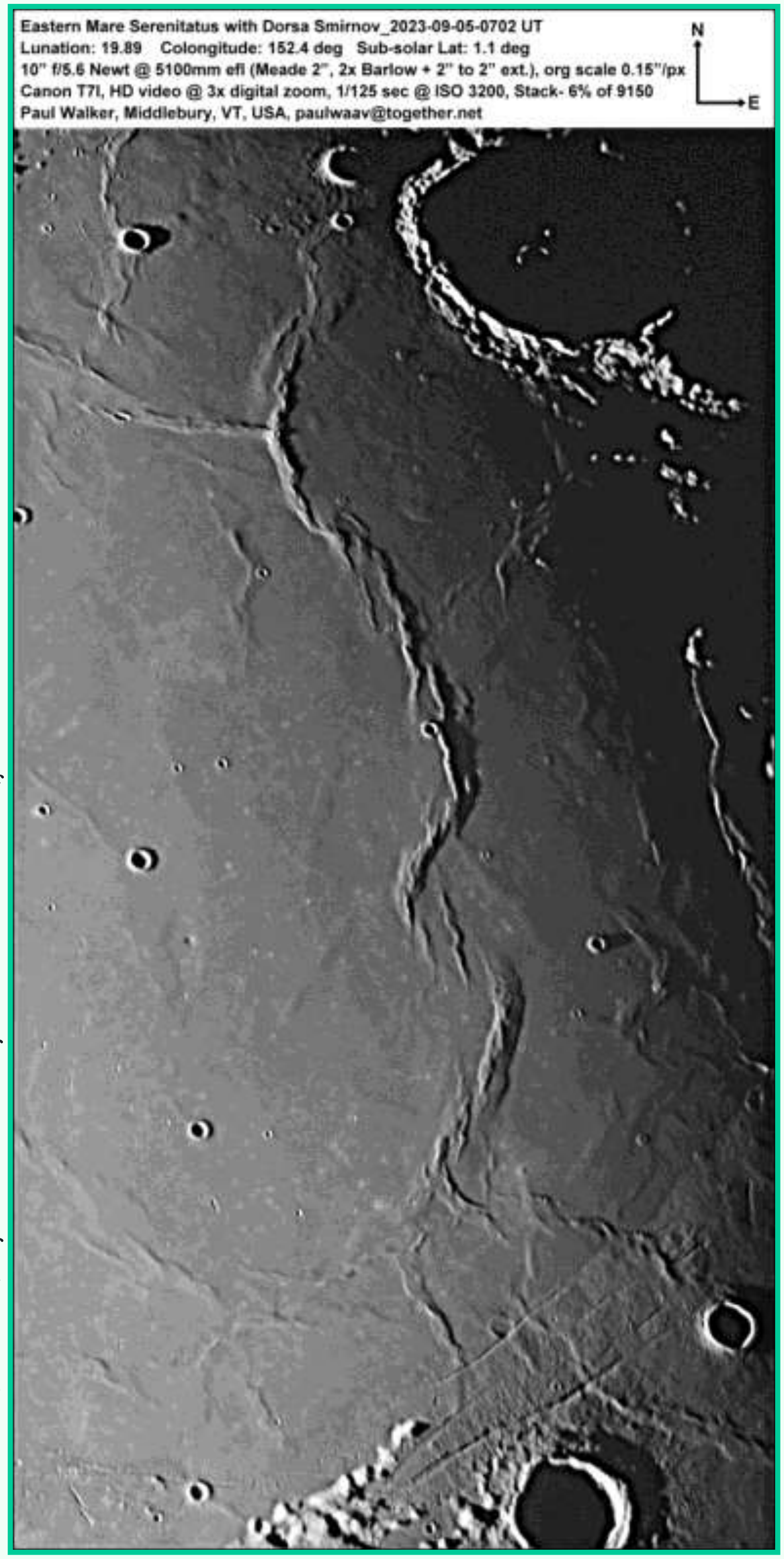


Image 31, Posidonius Y, *Alberto Anunziato, Paraná, Argentina. 2020 November 22 00:00-00:20 UT. Meade 105 EX Maksutov-Cassegrain telescope, 154x.*

Dorsa Smirnov and Eastern Mare Serenitatis
2023-09-05 and 2023-10-04
Paul Walker



2023-09-05 (Image 1) - The main feature here is obviously Dorsa Smirnov, the long winding wrinkle ridge going down the middle of the image. The rim of the large crater Posidonius fills the upper right corner. I am not particularly familiar with the forms wrinkle ridges come in and haven't viewed many under good lighting with good seeing. Having said, that it seems that Dorsa Smirnov's curves and large "disconnection's striking.

A very difficult visual target in this image is the tiny crater Posidonius Y. Here it sticks out like a sore thumb. Well, maybe more like a small boo boo on a thumb. For those not familiar with Posidonius Y, it is to the lower left of Posidonius sitting right on top of the wrinkle ridge, Dorsa Smirnov, where the ridge splits into a wide "Y" with one part going off to the left (west) at a right angle. There is also a long shadow being cast by the crater onto the floor of Mare Serenitatis. Due to an idiosyncrasy of our vision, I never noticed that shadow when viewing Posidonius Y. Granted I couldn't see Posidonius Y most of the time and the shadow would not exactly have been obvious. I have tried many times to spot Posidonius Y visually. The night I took this image I finally had success, using the same 10" f/5.6 scope used for the image with binoviewers and a pair of Hyperion zoom eyepieces. At ~360x and ~460x I was able to see it. At ~300x it was harder to see due to its small apparent size. The best view was at 360x. It seemed that I could hold the view of Posidonius Y for several moments at a time. In reality most of these moments were fleeting 1/2 seconds or less. When the Sun is higher and especially near Full Moon the general location of Posidonius fairly easy to see due to its light-colored ejection blanket.

FOCUS ON: Hiking In the Moon: Dorsa Smirnov
Dorsa Smirnov and Eastern Mare Serenitatis

There appears to be a smaller companion crater to Posidonius Y to the north touching it. However, neither LROC QuickMap's imagery nor the elevation tool shows any indication of one. Instead, it shows that what appears to be the left-hand rim of this "crater" is a narrow ridge lit up on one side and casting a shadow on the other. The right-hand "rim" appears to be the top of Dorsa Smirnov, maybe with its elevation "enhanced" with a little material from Posidonius Y (see Image 2).

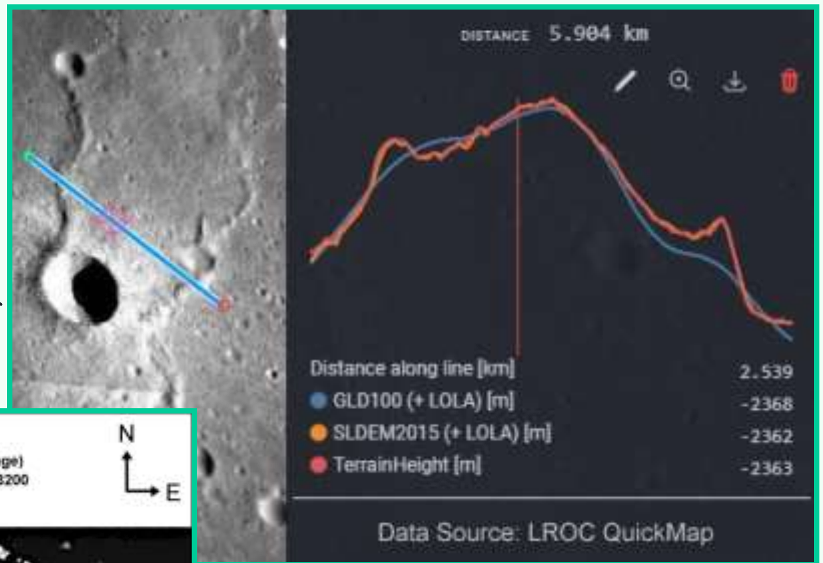


Image 2, Adjacent to Posidonius Y, *LROC.*

There are plenty of images that show well the difference that a small change in the lighting makes in the visibility of lunar features. Here I present a 2nd image (Image 3) that I took of this region that illustrates this well. Compare Image 1 with Image 3, taken 1 month later on 10/4/2023 and 0.64 of a day earlier. I was very lucky in the timing as well the seeing and was able to obtain a resolution in both images that is essentially the same. Based on the Moon's distance and the pixel count, I come up with 2.1 km (1.3 mi) for Posidonius Y, +/- 0.13km (0.08mi).

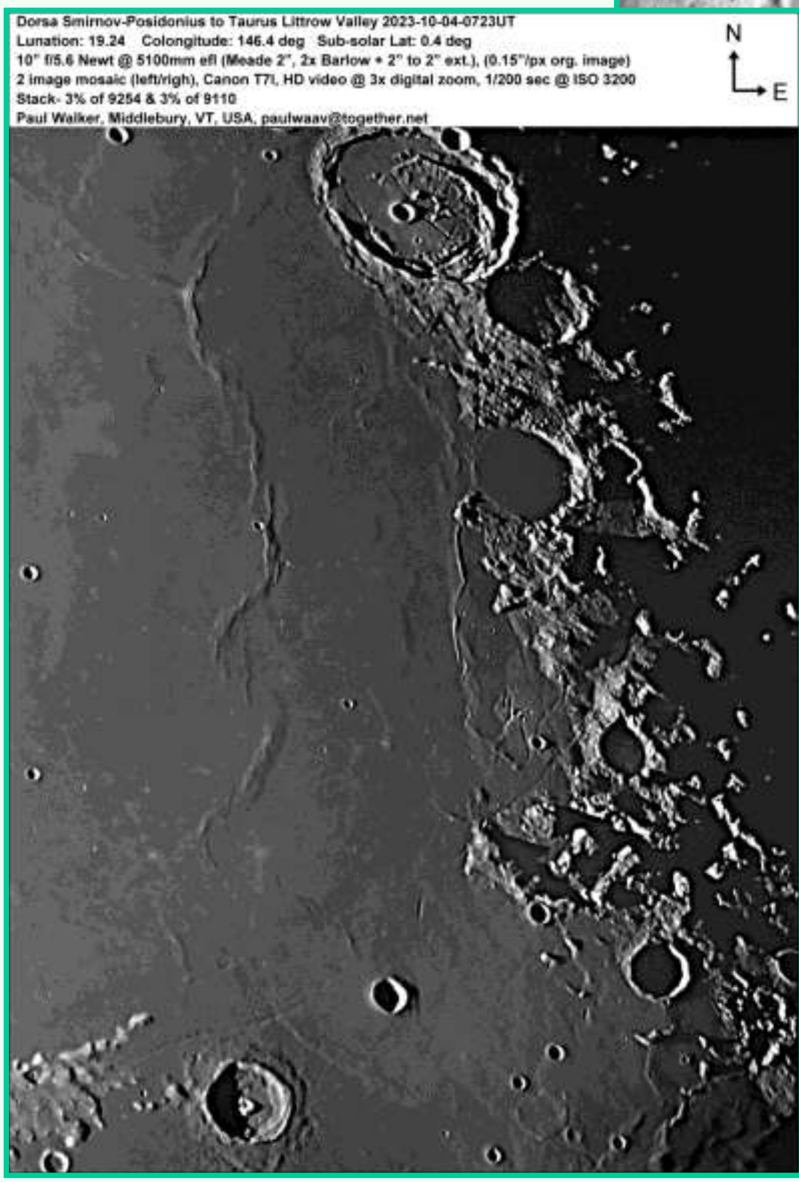


Image 3, Dorsa Smirnov-Posidonius to the Taurus Littrow Valley, *Paul Walker, Middlebury, Vermont, USA. 2023 October 04 07:23 UT, colongitude 146.4°. 10 inch f/5.6 Newtonian reflector telescope, 5,100 mm efl, Canon T7i camera.*

2023-10-04 (Image 3)- This is a mosaic of 2 images (west/east). They were taken 0.64 day “earlier” than the image I took on 2023/09/05. The image doesn’t show Dorsa Smirnov as well. But does show the wrinkle ridge, Dora Aldrovandi, on the East shore of Mare Serenitatis quite well. It also shows the Rima Littrow complex (1/3 the way up on the right) just west of Taurus-Littrow Valley (in shadow), the Rima Posidonius complex in Posidonius and the Rima Plinius complex on the south edge of Mare Serenitatis. While not part of this month’s Focus-On Feature, Le Monnier, a smooth floored crater catches the eye. It’s 1/3 the way down on the right side of the image in the “rough”, just breaking out into the mare. From the image it looks like the East edge of the floor sinks down to form a trough. Looking at the original stacked, but not processed, image I can’t tell if it’s real or not. Checking LROC QuickMap I see that it’s quite flat right to the edge (see Image 4). So, it’s just an illusion created by the contrast enhancement during post processing of an already high contrast transition. With LROC QuickMap one can also see that the floor is almost but not quite level. Only dropping about 140m (460 ft) west to east, a distance of 50 km (31 mi).

The smallest, high contrast, features visible in this image, such as the narrowest parts of Rima Posidonius on the floor of Posidonius, are ~6 pixels across on the original image. With the Moon’s distance of 380,486 km at the time, and a resolution of ~0.145”/pixel on the original image, this equates to ~1.6 km (1.0 mi). For Posidonius Y, I come up with a diameter the same as for the 2023/09/05 image, 2.1 km (1.3 mi). Nice to see such consistency. Going back to the false crater seen in Image 1 next to Posidonius Y- the narrow ridge is 4 pixels across, so I can say the smallest features detectable are about 1.1 km (0.7 mi).

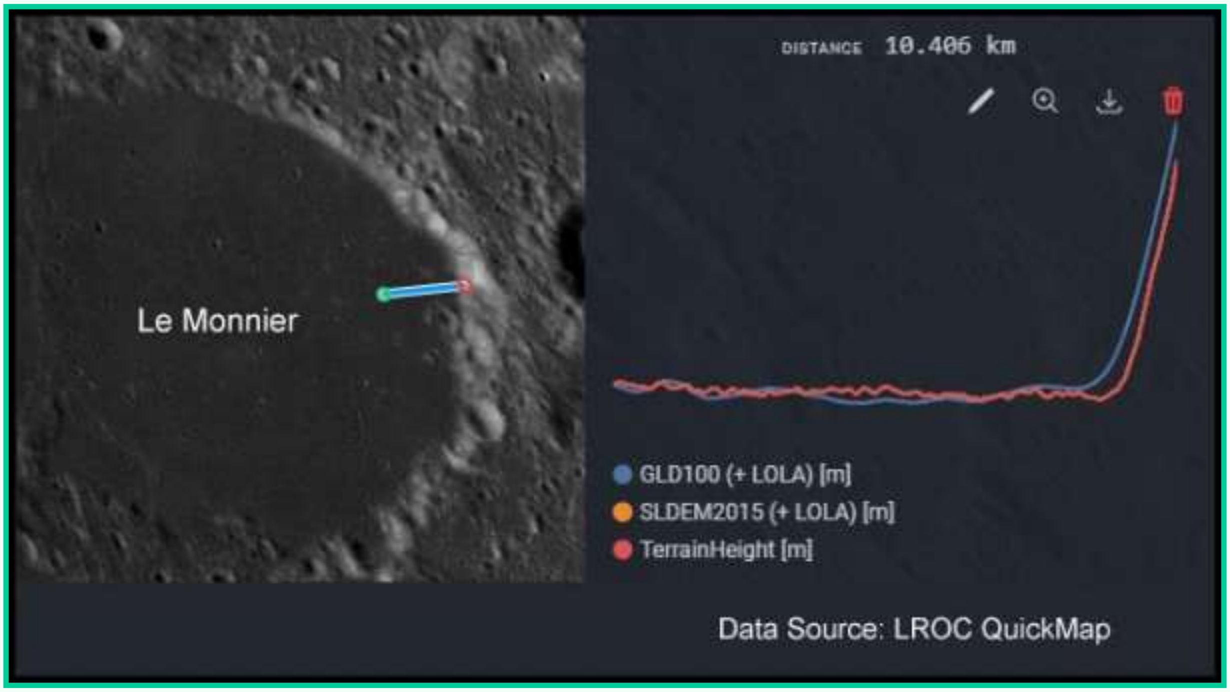


Image 4, le Monnier, *LROC.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov
Dorsa Smirnov and Eastern Mare Serenitatis

This curious location of Posidonius Y is illustrated with IMAGE 32 and 33. In IMAGE 34 this curious crater is seen very clearly, and if we see IMAGE 35 and IMAGE 36, we see that, in the complete panorama of the Serpentine Ridge, Posidonius and it is a small crater but it is the brightest point, it is surely very recent (IMAGE 37).

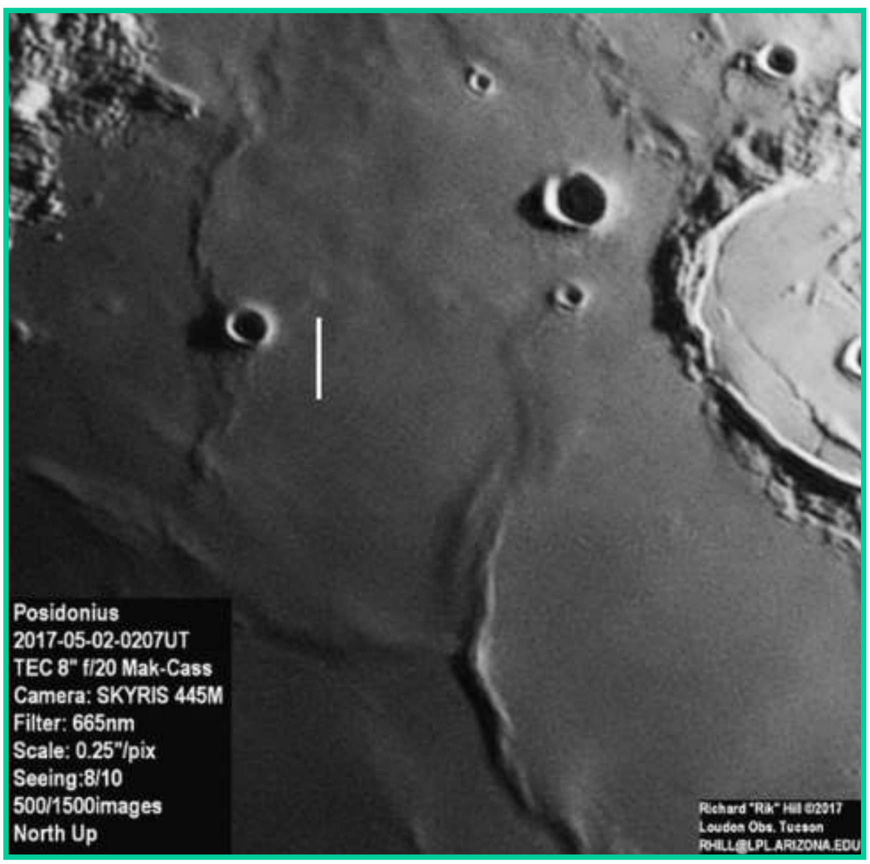


Image 32, Dorsa Smirnov, *Eduardo Horacek, Mar del Plata, Argentina. 2023 October 20 00:01 UT. 150 mm Maksutov-Cassegrain telescope, Canon Rebel T5i camera.*

Image 33, Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2017 May 02 02:07 UT. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 445M camera. Seeing 8/10.*

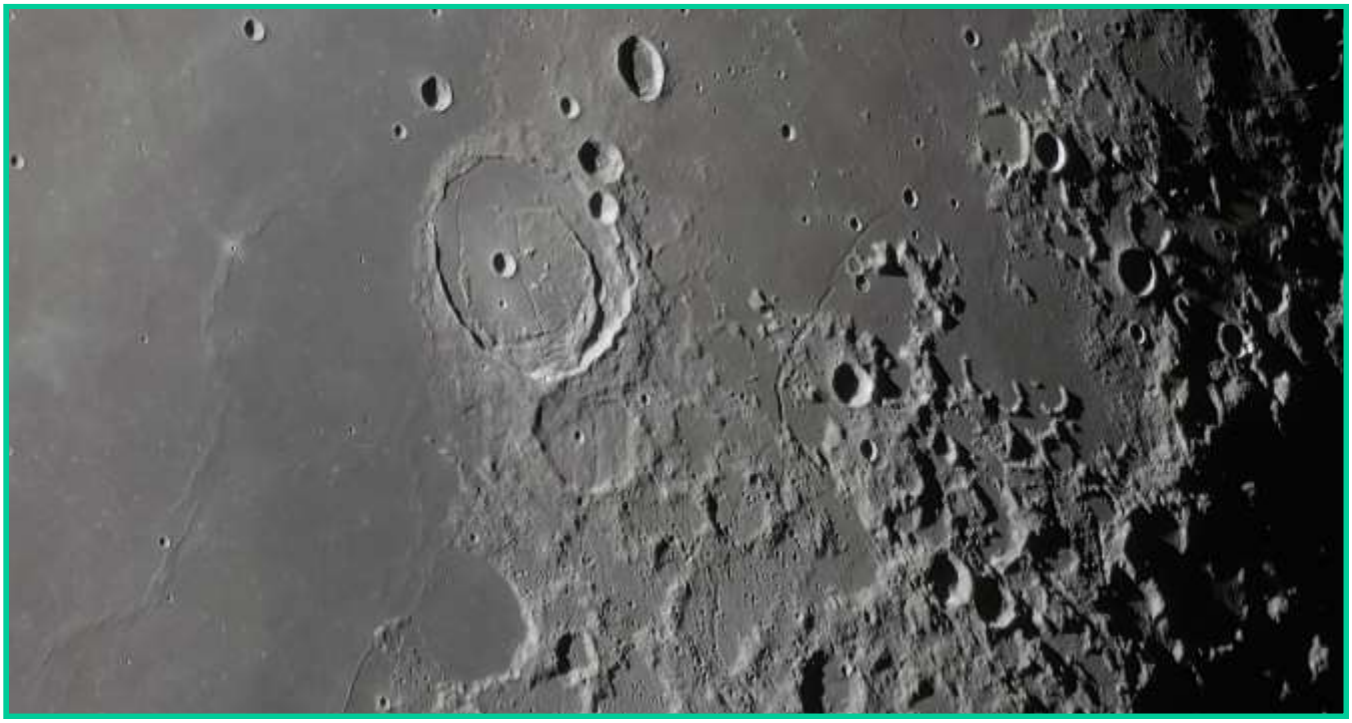


Image 34, Posidonius, *Don Capone, Waxahachie, Texas, USA. 2023 August 05 10:08 UT. Orion xx16g at f/11, UV/IR cut filter, 2 x barlow, ADC, ASI678MC camera.*

Image 35, Posidonius, *David Teske, Louisville, Mississippi, USA. 2020 October 06 05:01 UT, co-longitude 138.5°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 6-7/10.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Image 36, Posidonius, *David Teske, Louisville, Mississippi, USA. 2020 November 04 05:58 UT, colongitude 131.9º. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI120mm/s camera. Seeing 9/10.*

Image 37, Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2019 October 19 07:16 UT, colongitude 149.8º. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 445M camera. Seeing 7/10.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Further below Posidonius Y, we see that in segment 8 and to the left (west) a very gentle slope is clearly seen, which begins at point 1 and ends at point 2 of IMAGE 38, the eastern slope is more abrupt in his descent. Clearly the surface of Mare Serenitatis to the east of Dorsum Smirnov is higher than the surface to the west. Point 3 indicates a secondary height, a ridge lower than the main ridge. Once again, a detail from IMAGE 17 (IMAGE 39) shows us a very complex panorama, further south of the panorama from IMAGE 38: at the top we see an arch with the crest migrating from one margin to the other, while at the bottom a more complex parallel segment appears.

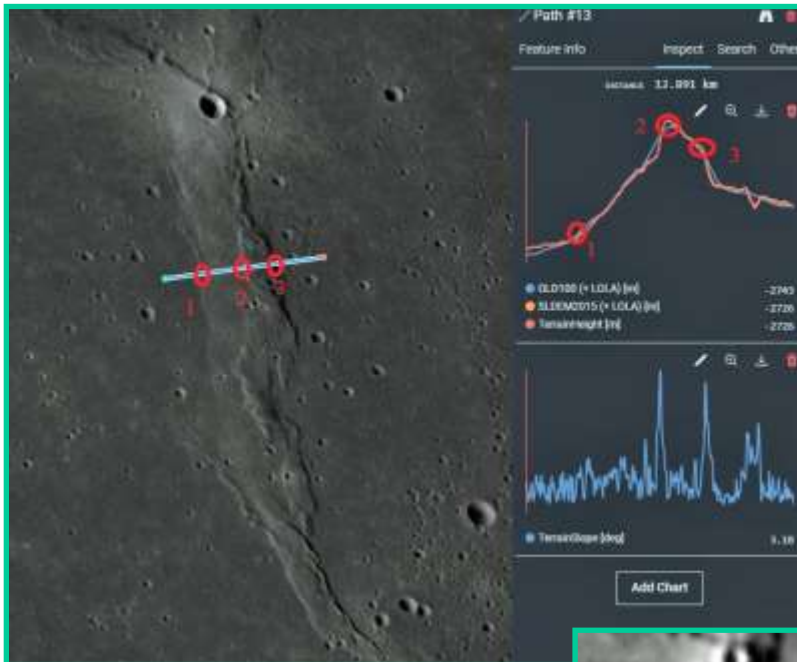


Image 38, Dorsa Smirnov, *LROC QuickMap.*

Image 39, Dorsa Smirnov, *Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope. This is a close-up of image 17.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Further south, passing the small crater Very (5 km in diameter), the relief is again similar to that observed in IMAGE 38 (IMAGE 40), we see it in IMAGE 41, which is another detail of IMAGE 17, it shows the area of most complex and interesting relief of Dorsa Smirnov: to the north of Very two parallel segments, with their respective crests and other minor segments to the right, the crest passes to the right of Very in its highest part and then is a little lower (which can be deduced because there is less shadow and we can see the arch to the right). Further to the south the crest is interrupted, while the arch bifurcates, to the right we see a secondary ridge. In the lower part of the image, we see how segment 8 ends, in a chaotic manner, with "echelon" crests and even a crest that intersects the arch. The southern end of segment 8 is much less steep, as we see in the relief in IMAGE 42.

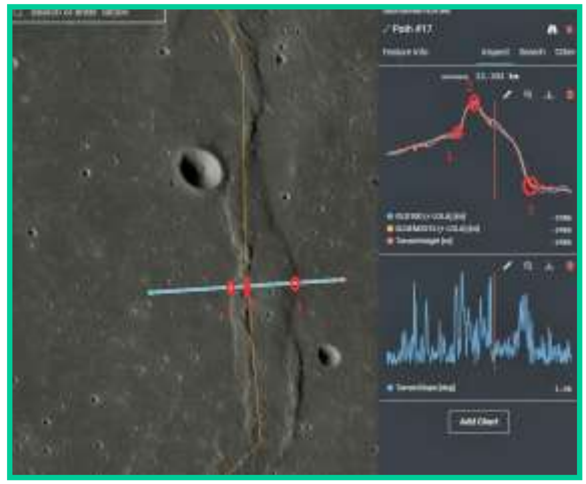


Image 40, Dorsa Smirnov, *LROC QuickMap.*

Image 41, Dorsa Smirnov, *Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope. This is a close-up of image 17.*

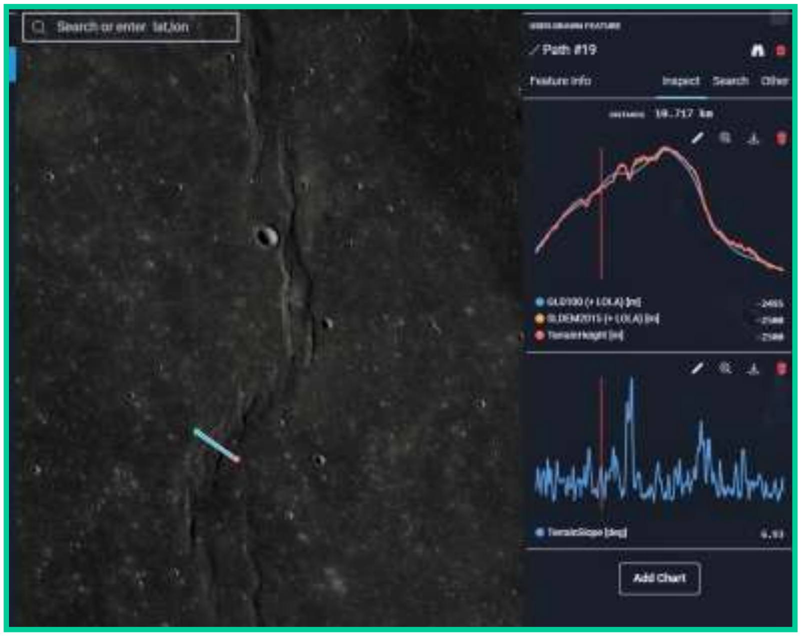


Image 42 Dorsa Smirnov, *LROC QuickMap.*

Segment 9 has the typical structure of the crest passing from one side of the arch to the other IMAGE 43 and the ground to the east is much lower than to the west of the dorsum. This segment can be clearly seen in IMAGE 44 and 45, in which segments 10 to 12 are also perceived, which do not belong to Dorsa Smirnov but to Dorsa Lister, but (as we saw previously) it is traditionally considered part of the Serpentine Ridge. Segments 10 (IMAGE 46) and 11 (IMAGE 47) have their gentle slope towards the east, while segment 12 has it towards the west (IMAGE 48), which is a characteristic of all wrinkle ridges and specifically Serpentine Ridge: "A curious aspect of these ridges is that in some sections the eastern side of the ridge rises steeply from the mare floor with the western side gently sloping down while other sections are steep in the west with gentle slopes toward the east" (Garfinkle). Segment 12 seems to have a more abrupt relief than the previous two, so we could conclude that Dorsa Lister is made up of two units: segments 10-11 and segment 12. This area can be seen very clearly in IMAGE 49.

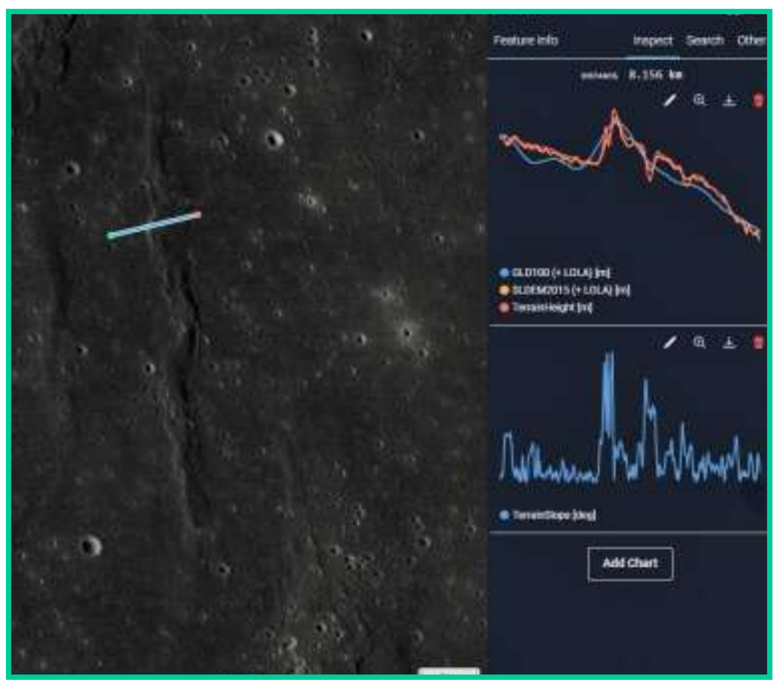


Image 43 Dorsa Smirnov, *LROC QuickMap.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Image 44, Dorsa Smirnov, *Anthony Harding, Northeast Indiana, USA. 2023 August 22 01:11 UT, colongitude 351.008º. Orion 90 AstroView Achromatic refractor telescope, 2.5x PowerMate, ZWO ASI290MM camera. Seeing 5/10, transparency 3/6. Anthony adds:* "Another capture highlighting Dorsa Smirnov. Aggressive capture and processing reveal a lot of detail in the Dorsa. Other Dorsa on the floor of Mare Serenitatis are also plainly visible."

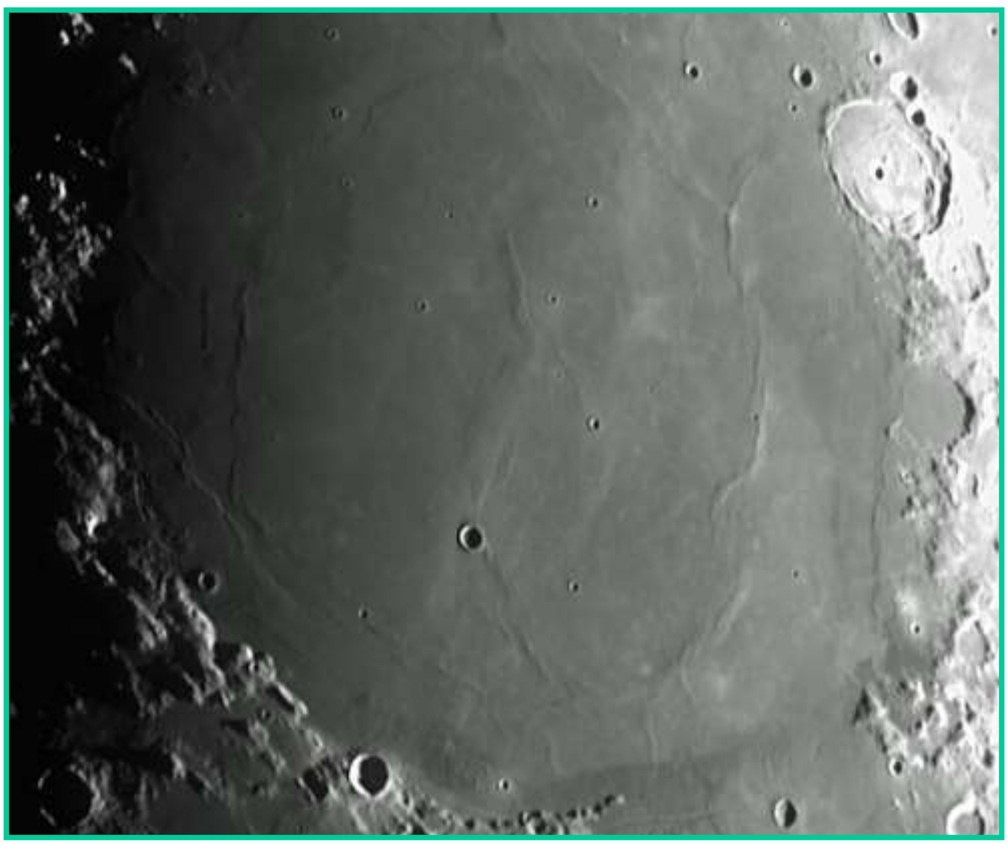


Image 45, Dorsa Smirnov, *Anthony Harding, Northeast Indiana, USA. 2023 August 22 01:05 UT, colongitude 350.957º. Orion 90 AstroView Achromatic refractor telescope, 2.5x PowerMate, ZWO ASI290MM camera. Seeing 5/10, transparency 3/6. Anthony adds:* "Here is a capture highlighting Dosa Smirnov. The capture settings and processing were done specifically to highlight the features of Dorsa Smirnov. The path of the Dorsa through Mare Serenitatis is plain, and shows a good amount of detail. Its broken, winding path can be clearly seen."

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

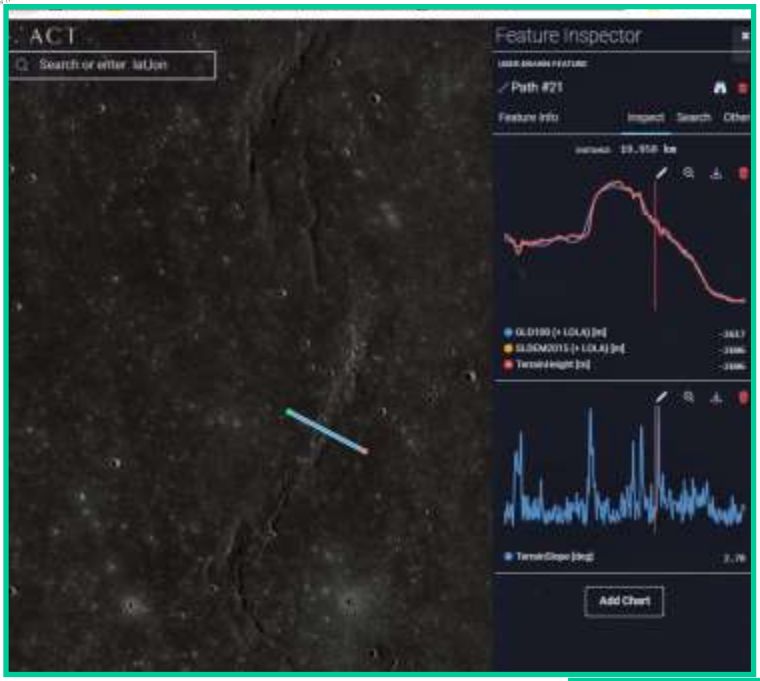


__Image 46, Dorsa Smirnov,__ LROC QuickMap.

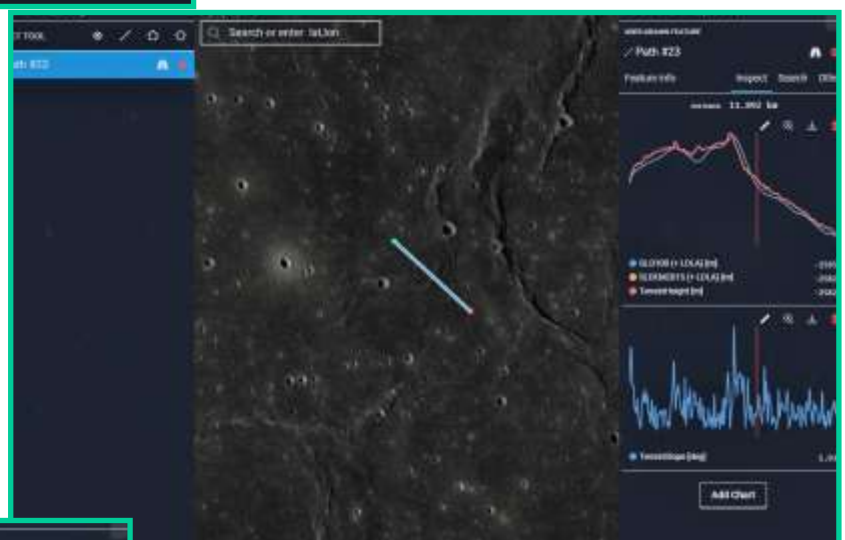


__Image 47, Dorsa Smirnov,__ LROC QuickMap.

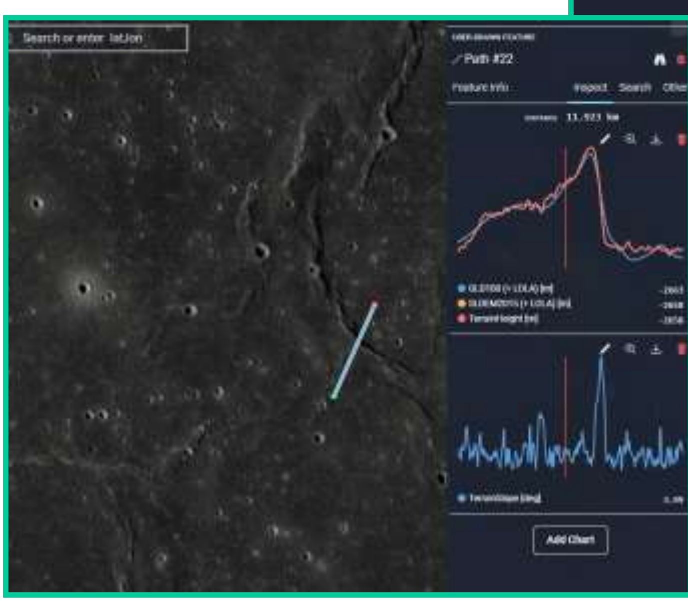


__Image 48, Dorsa Smirnov,__ LROC QuickMap.

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

***Image 49, Posidonius,** Sergio Babino, Montevideo, Uruguay, SAO. 2020 March 13 04:58 UT. 203 mm catadrioptic telescope, ZWO ASI174 MM camera.*

Segment 10 is much more imposing than the others that make up Dorsa Lister, which can be seen in IMAGE 50. In IMAGE 51 (another detail from IMAGE 17) we see that in the upper area (north) the crest is very wide and it has a chaotic plurality of crests, in turn there is a dramatic change in height where the arch begins (what Aubele calls "rise" and would be the first of three superimposed components, instead of two (arc and crest): "a linear elevation broad, which may not always be present or may be visible only at low illumination angles". The area marked by the arrow indicates a series of at least 5 height changes, which is not reflected as much (once again) on the LRO map (IMAGE 52).

***Image 50, Dorsa Smirnov,** Anthony Harding, Northeast Indiana, USA. 2023 August 22 00:57 UT, colongitude 350.855º. Orion 90 AstroView Achromatic refractor telescope, 2.5x PowerMate, ZWO ASI290MM camera. Seeing 5/10, transparency 3/6. Anthony adds: "*This is a wide shot of Mare Serenitatis with Dora Smirnov. The exposure, gain, and processing were accomplished to highlight Dorsa Smirnov. Its meandering trail can be plainly seen snaking southward through the eastern part of the Mare.

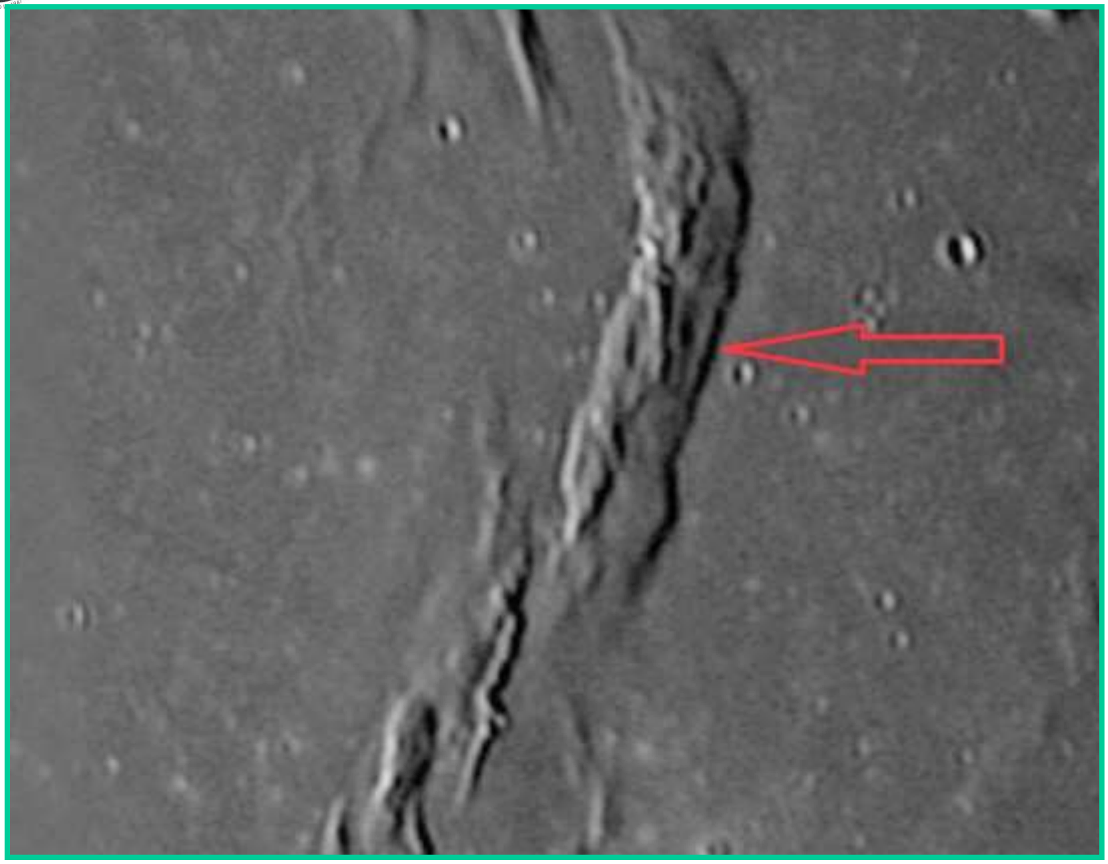


Image 51, Dorsa Smirnov, *Jeff Grainger, Cumbria, UK. 2023 September 05 01:57 UT. Celestron 11 inch Schmidt-Cassegrain telescope. This is a close-up of image 17.*

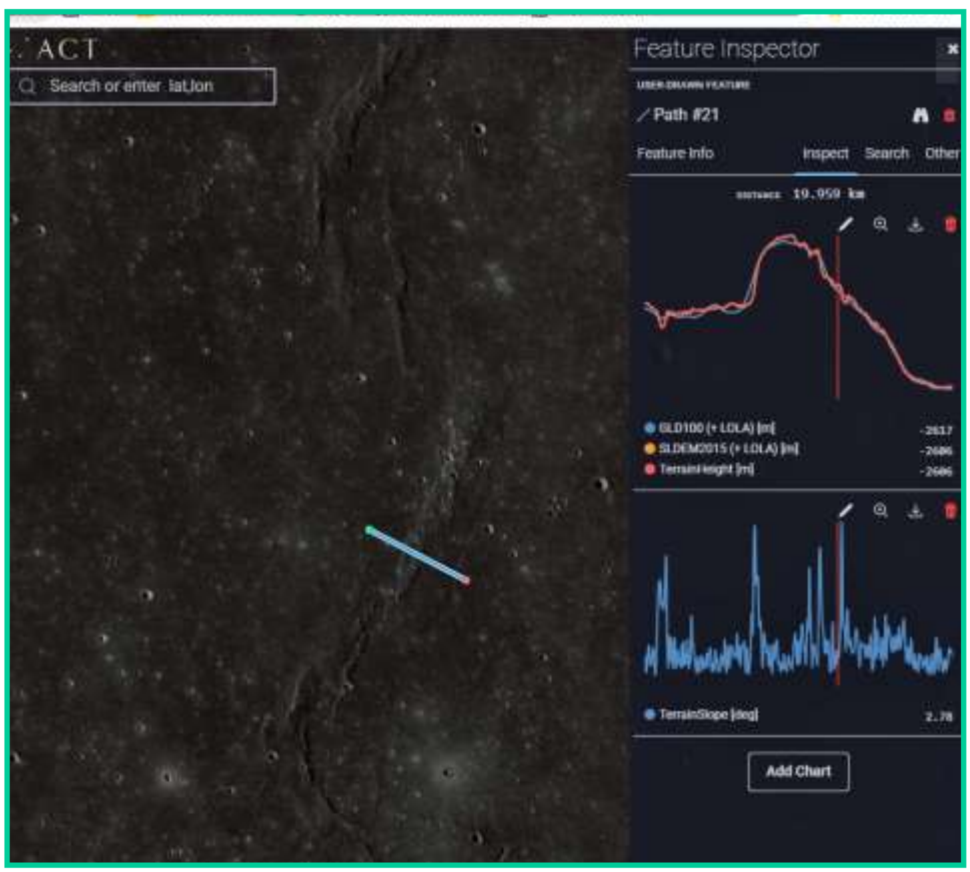


Image 52, Dorsa Smirnov, *LROC QuickMap.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Segment 11 appears to be only the completion of segment 10 (IMAGE 53), while segment 12 (IMAGE 54) is a more classic wrinkle ridge, with the crest passing along the northern margin of the arch, which is clearly visible near the terminator, as in IMAGE 55.

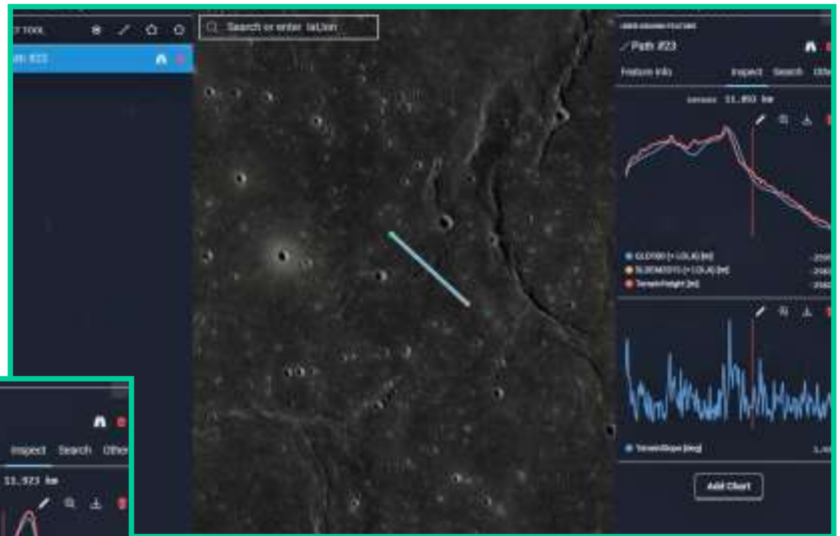


Image 53, Dorsa Smirnov, *LROC QuickMap.*

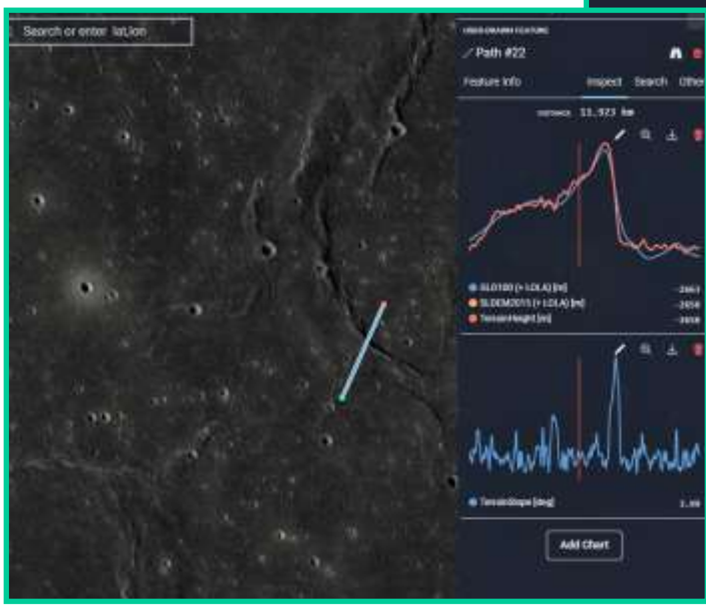


Image 54, Dorsa Smirnov, *LROC QuickMap.*

Image 55, Dorsa Smirnov, *Eduardo Horacek, Mar del Plata, Argentina. 2023 October 19 23:15 UT. 150 mm Maksutov-Cassegrain telescope, Canon Rebel T5i camera.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

We are finishing our telescopic walk-through Dorsa Smirnov, dreaming that one day humans will be able to walk along these elevations. We hope you enjoyed it. Our wrinkle ridge has not been fairly portrayed by the different space missions; in the Apollo Image Atlas archive of the Lunar and Planetary Institute there is only one image, from Apollo 15, with front lighting in which not many details are visible. We close this walk with a historical image that Michel Deconinck sent us from France. It was obtained at the Observatoire du Pic du Midi, in one of its domes, whose construction was financed by NASA to add this historic observatory to the phenomenal effort to refine lunar cartography. For almost 10 years, the photographs taken in the heights of the Pyrenees (of which more than 60,000 are still preserved) began a long journey through a cable car at the beginning and ending on a plane landing in the United States to be developed. With that same telescope, IMAGE 56 was obtained in 1988.

Image 56, Dorsa Smirnov, *Jean Bourgeois, Pic du Midi observatory, altitude 2877m, Pyrénées, France. 1988 December 28 05:45 UT. 1 meter f/10 reflector telescope (!), Kodax TP2415, raw photo, no post treatment. Good transparency (6) but low turbulence (seeing 8?).*

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Dorsa Smirnov, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:11 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

Posidonius, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2017 May 02 02:07 UT. TEC 8 inch f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 445M camera. Seeing 8/10.*

FOCUS ON: Hiking In the Moon: Dorsa Smirnov

Wrinkles
Rik Hill

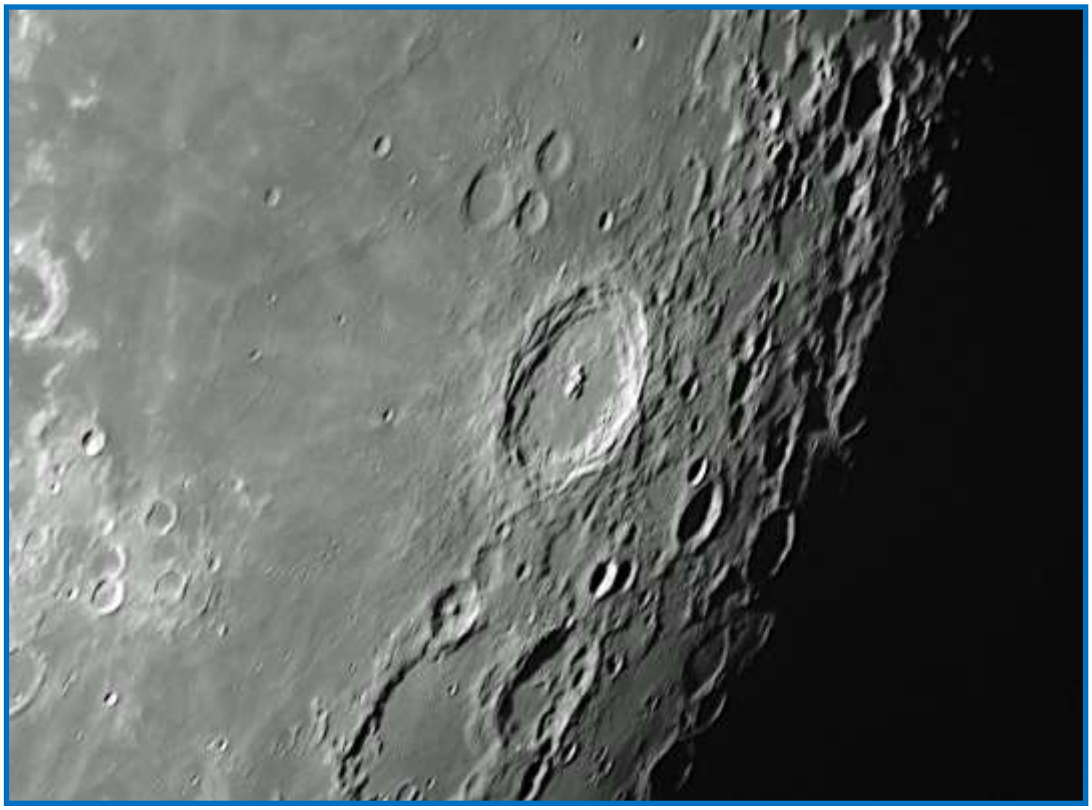
At my age one usually does not invite conversation about wrinkles. But, no matter, I will plunge into the topic! Here we see sunset on the great crater Posidonius (99 km dia.) in the upper right of this image with the wonderfully fractured floor. Below this crater is another much older crater, Charcornac (53 km). You can guess at its relative age just by the ruin of its walls and the many rimae that cross its floor. Moving further south we come to the fascinating embayment opening on Mare Serenitatis, Le Monnier (63 km) also very old, possibly going back to just after the formation of the Moon itself. Then at the bottom of this right edge is another embayment with a crater above and below filled with rough peaks. The crater below is Vitruvius (31 km) and above is none other than Littrow (32 km) with the rough peaks being near the Taurus-Littrow landing site of Apollo 17.

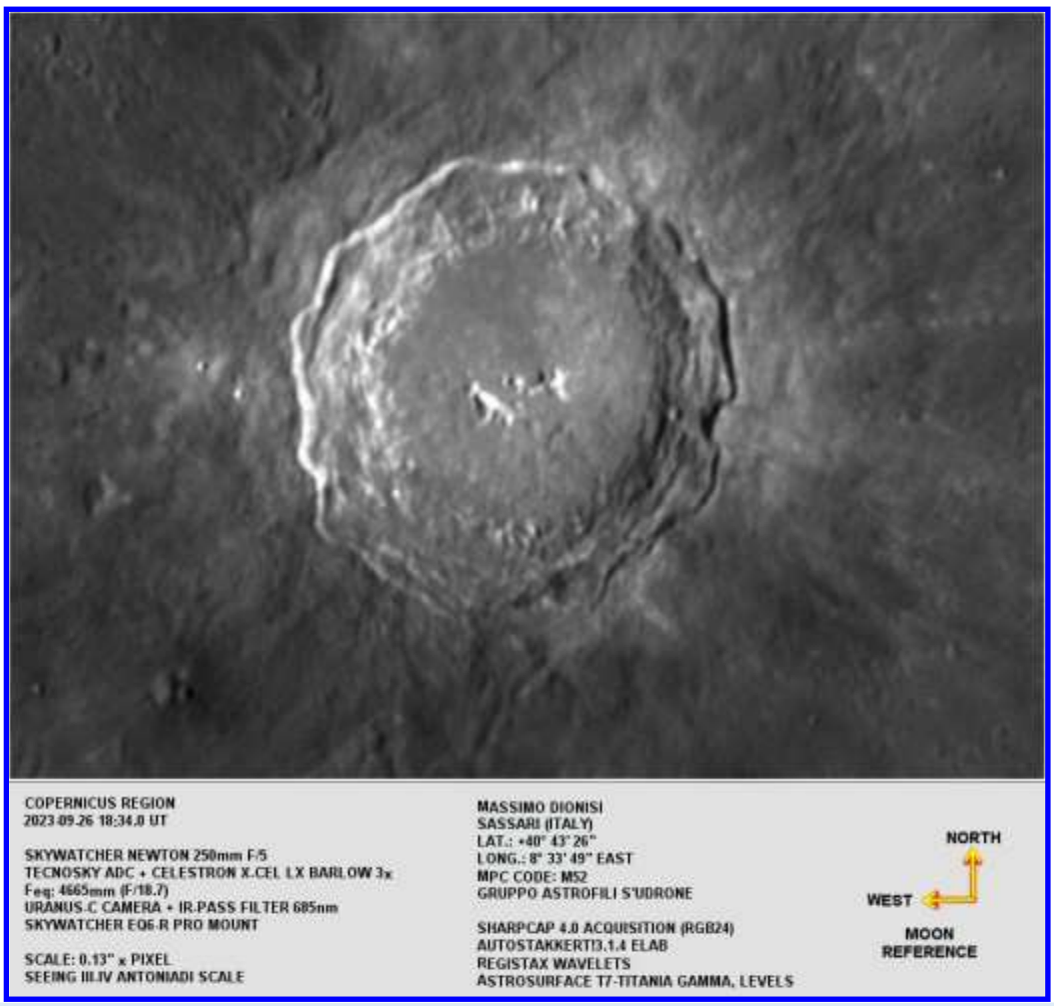
Between Littrow and Le Monnier is what we used to call "wrinkle ridges". The two here form a fairly straight line named Dorsa Aldrovandi. Then further out in the mare and parallel to this coastline is another larger wrinkle ridge Dorsa Smirnov, not having anything to do with a beverage but named for 20th century Soviet naturalist. In my early days of lunar observing, early 1960s, this was called the "Serpentine Ridge" and it took a little work before I clearly saw it in my little 2.4" refractor. In a larger telescope it can be quite impressive. The uppermost end of the main dorsum is split into a "Y" and the bottom end terminates just north of the crater Plinius (44 km) seen at the bottom edge of this image where Smirnov splits off into Dorsa Lister and farther on, Dorsum Nicol. Where the dorsum splits on the north end you will see a white spot at that point. You can see a tiny 2 km crater in the middle of that white spot. This is Posidonius Y. The crater and its white ejecta has nothing to do with the dorsum, just a coincidental juxtaposition and is actually just a couple kilometers south of the split.

Before leaving, notice the large 50 km ghost crater to the upper left of Plinius in Serenitatis. It even has a ghost central peak!

FOCUS ON: Hiking In the Moon: Dorsa Smirnov
Wrinkles

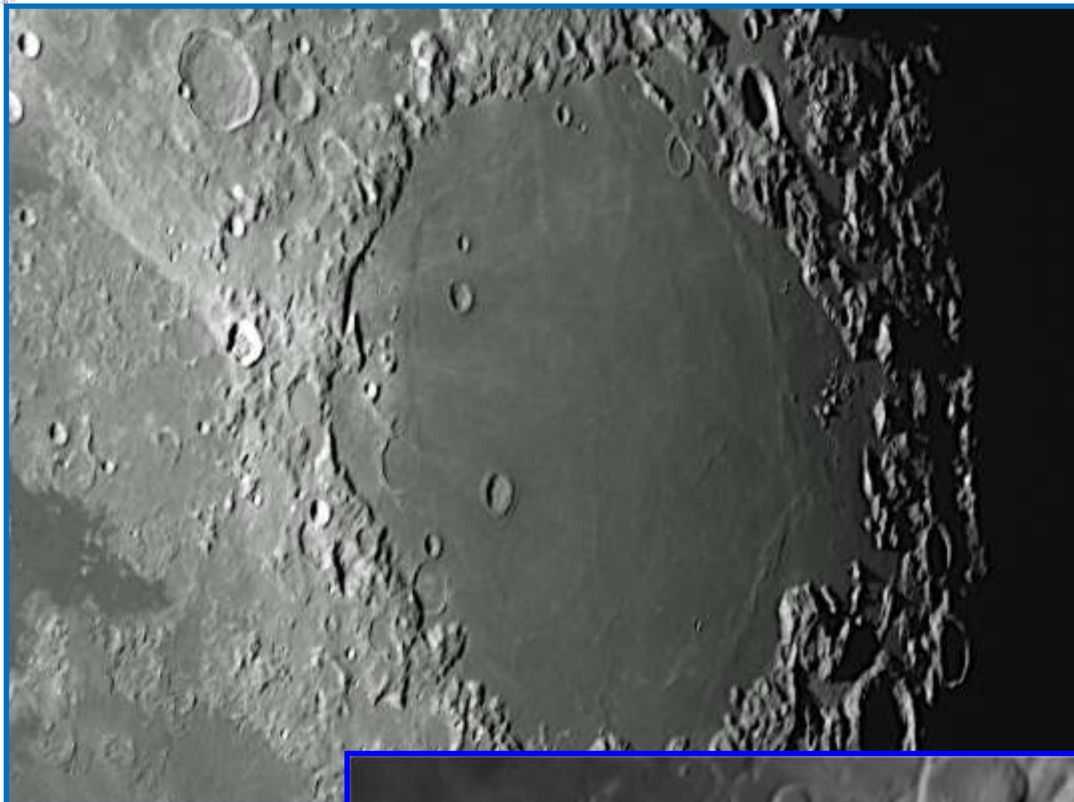
Langrenus, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:32 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, IR filter, ZWO ASI120mm/s camera.*





Copernicus, *Massimo Dionisi, Sassari, Italy. 2023 September 26 18:34 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Recent Topographic Studies



Mare Crisium, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:38 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, IR filter, ZWO ASI120mm/s camera.*

Milichius, *Massimo Dionisi, Sassari, Italy. 2023 September 26 18:27 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Recent Topographic Studies

***Petavius,** Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:34 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, IR filter, ZWO ASI120mm/s camera.*

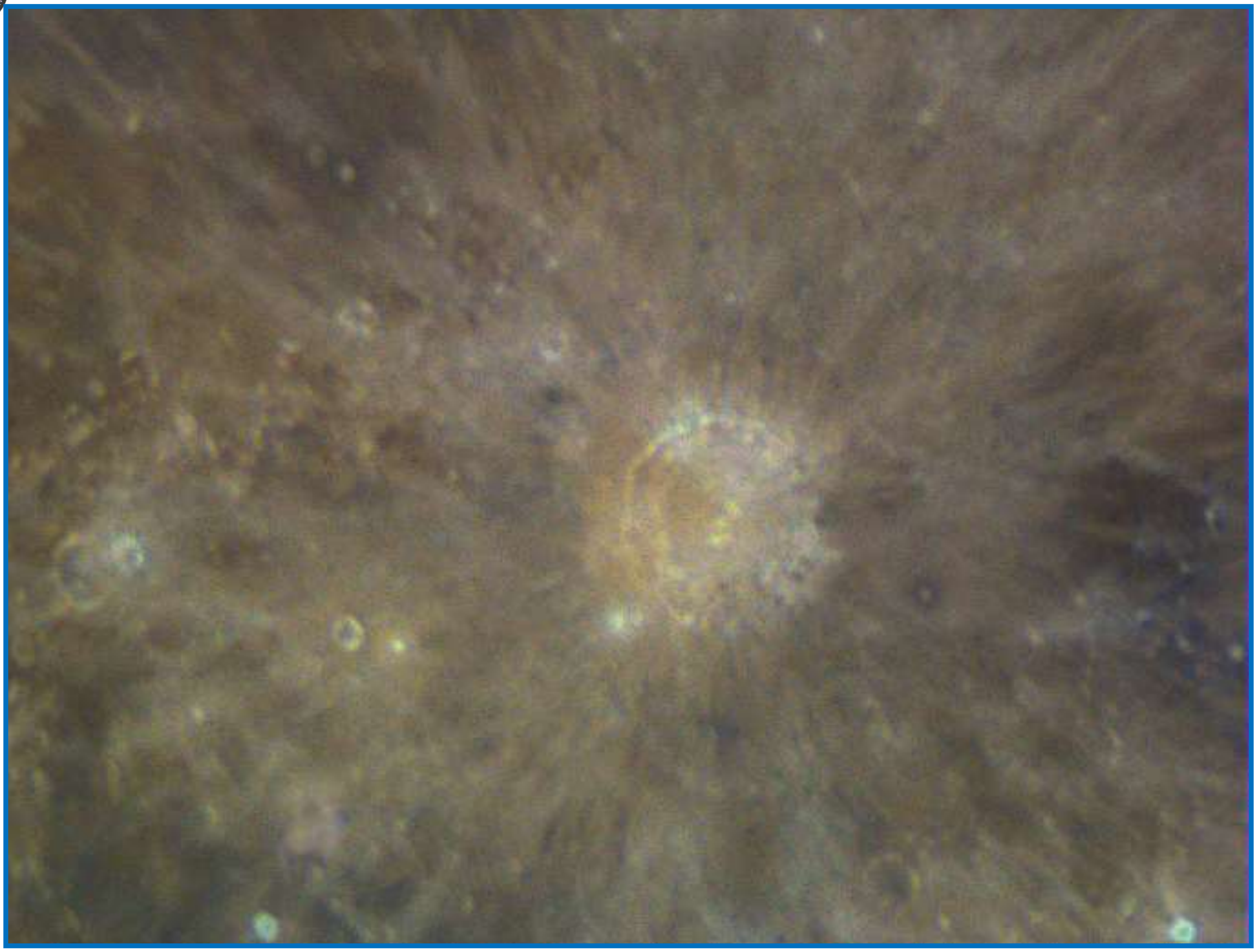
***Gruithuisen,** Massimo Dionisi, Sassari, Italy. 2023 September 26 19:00 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Recent Topographic Studies

Petavius, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:22 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

Aristarchus, *Massimo Dionisi, Sassari, Italy. 2023 September 26 19:00 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

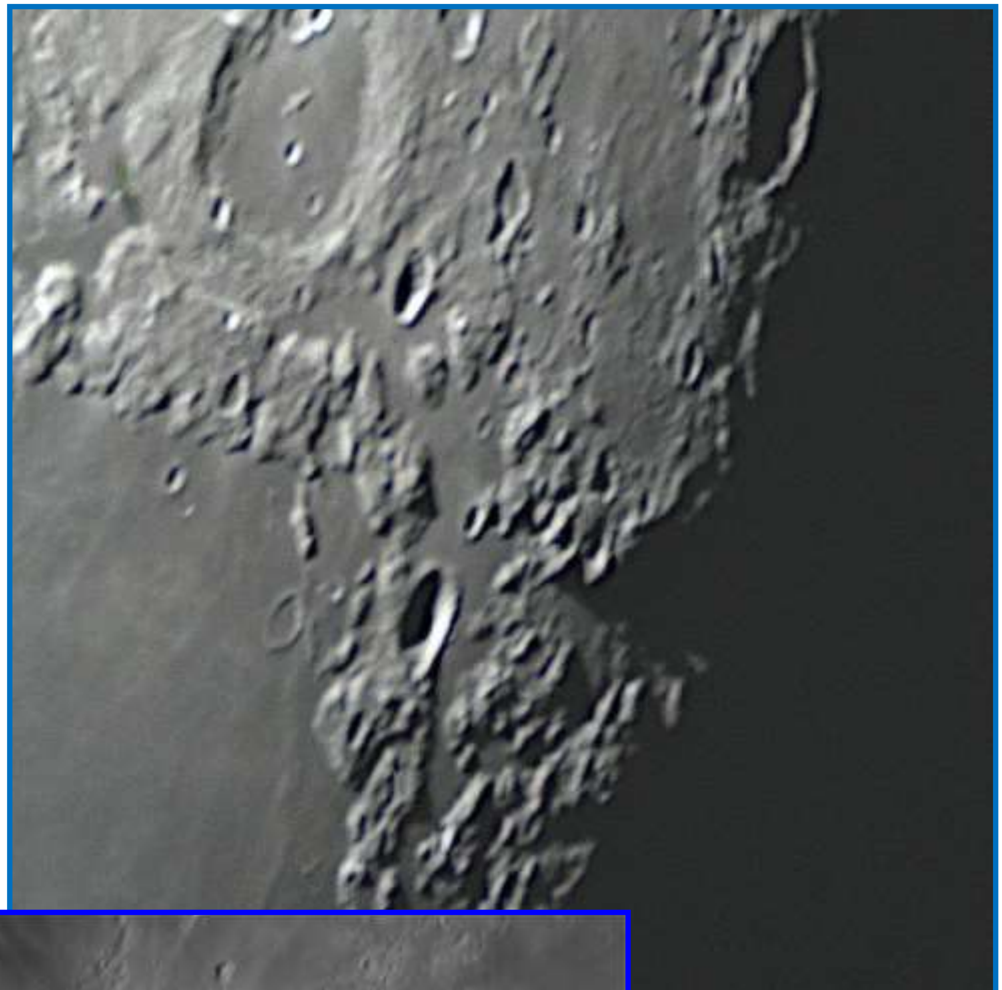
Recent Topographic Studies



***Copernicus,** Gonzalo Vega, Oro Verde, Argentina, AEA. 2023 October 01 04:02 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

***Schickard,** Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 02:56 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

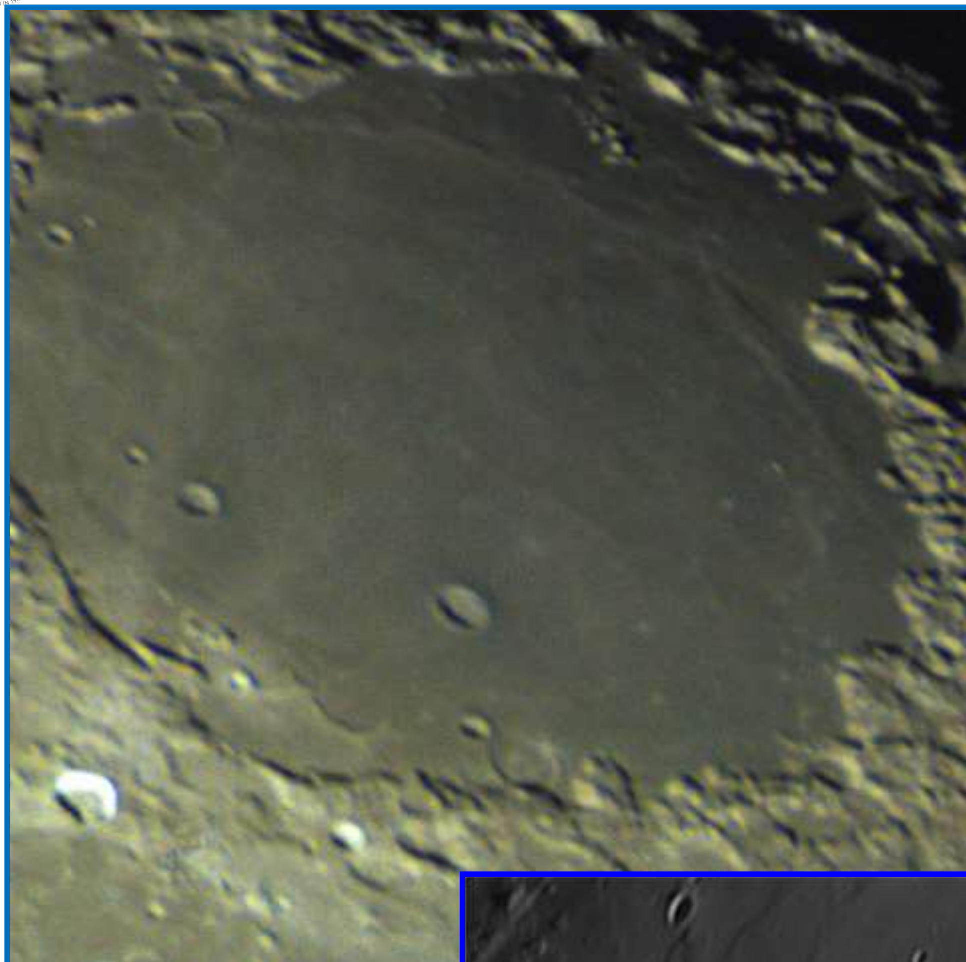
Recent Topographic Studies



Hahn, *Gonzalo Vega, Oro Verde, Argentina, AEA. 2023 October 01 04:15 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

Kepler, *Massimo Dionisi, Sassari, Italy. 2023 September 26 18:40 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Recent Topographic Studies

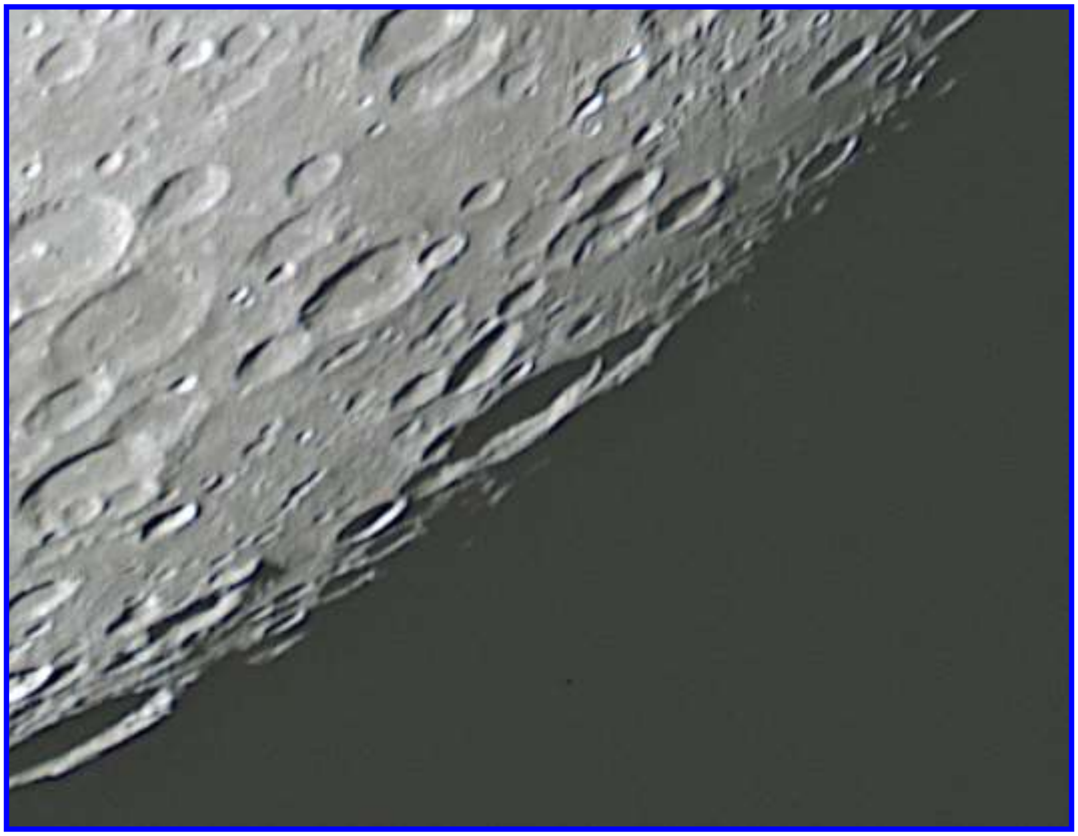


Mare Crisium, *Gonzalo Vega, Oro Verde, Argentina, AEA. 2023 October 01 04:14 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

Prinz, *Massimo Dionisi, Sassari, Italy. 2023 September 26 19:03 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Recent Topographic Studies

Pontécoulant, *Walter Ricardo Elias, Oro Verde, Argentina, AEA. 2023 October 01 04:28 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*



Encke, *Massimo Dionisi, Sassari, Italy. 2023 September 26 19:19 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

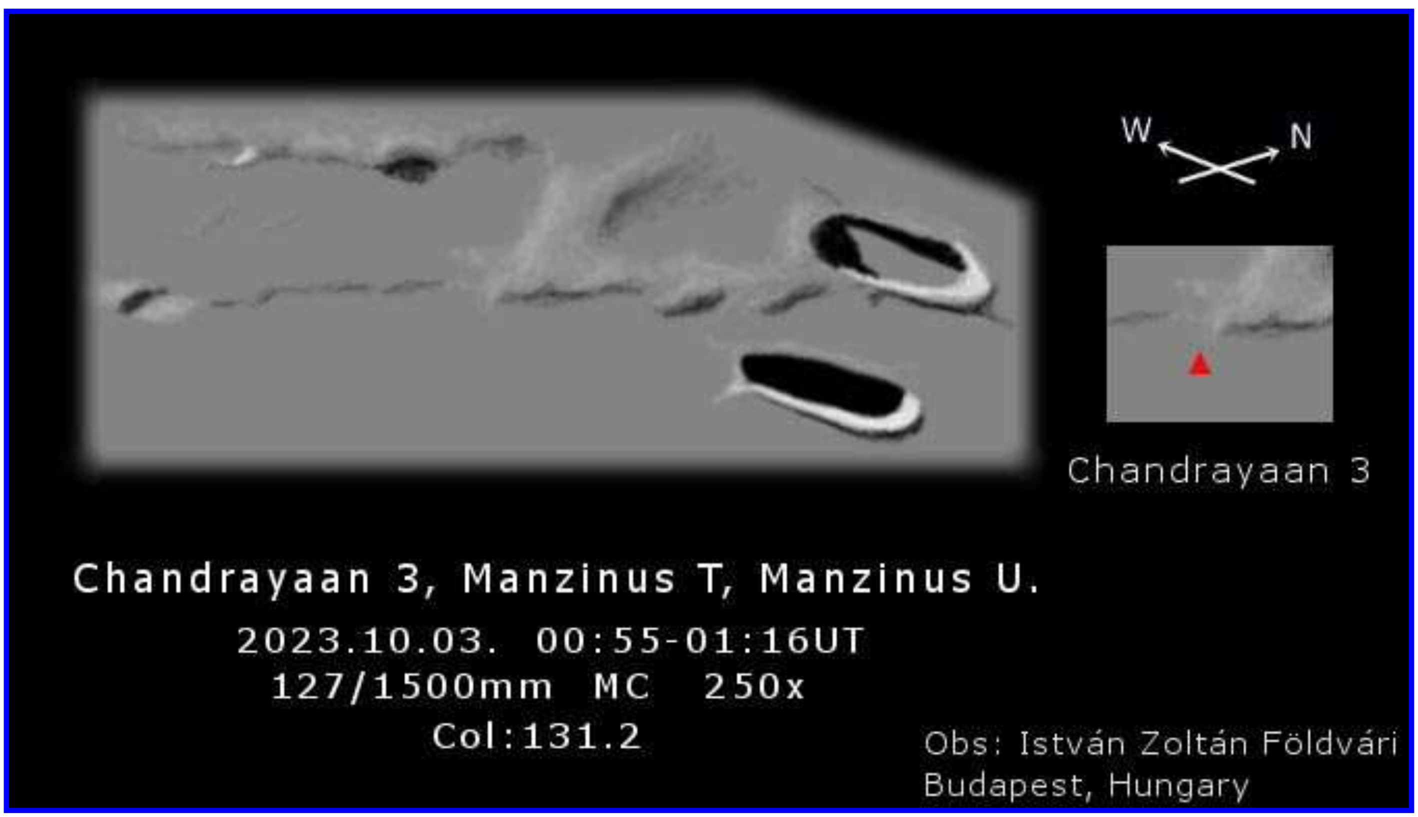
Langrenus, *Gabriel Kloster, Oro Verde, Argentina, AEA. 2023 October 01 04:20 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, QHY5-11C camera.*

Marius, *Massimo Dionisi, Sassari, Italy. 2023 September 26 19:11 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

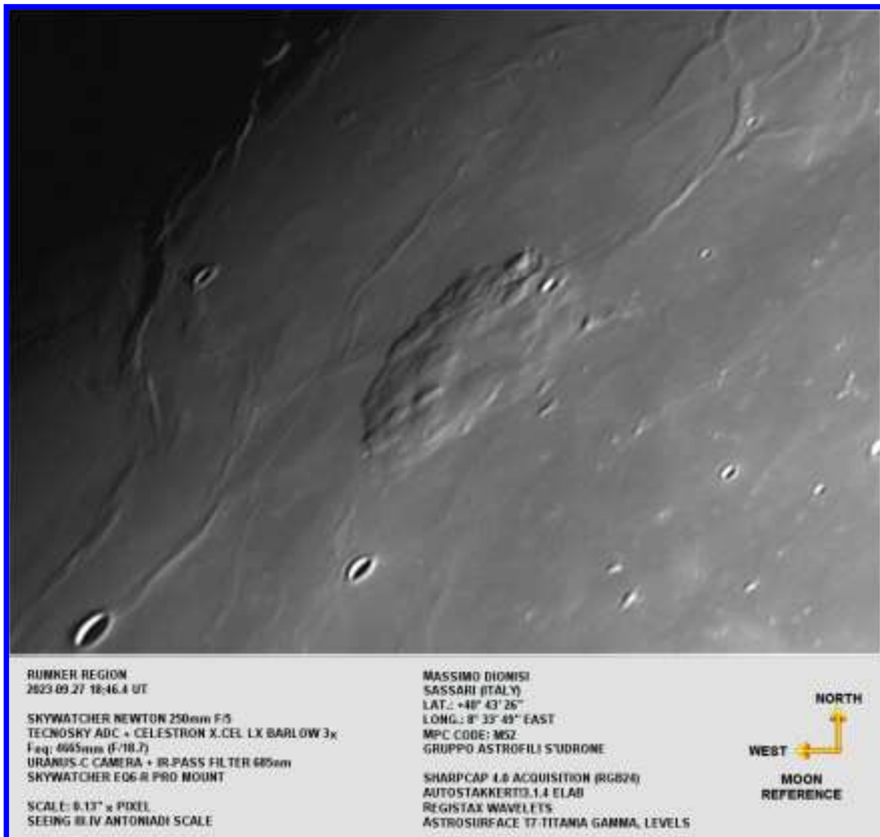
Recent Topographic Studies

Kepler, *Massimo Dionisi, Sassari, Italy. 2023 September 26 19:16 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Chandrayaan 3, Manzinus T and Manzinus U, *István Zoltán Földvári, Budapest, Hungary. 2023 October 03 00:55-01:16 UT, colongitude 131.2°. 127 mm Maksutov-Cassegrain telescope, 1,500 mm focal length, 6 mm orthoscopic, 250x. Seeing 4/10, transparency 5/6.*



Recent Topographic Studies

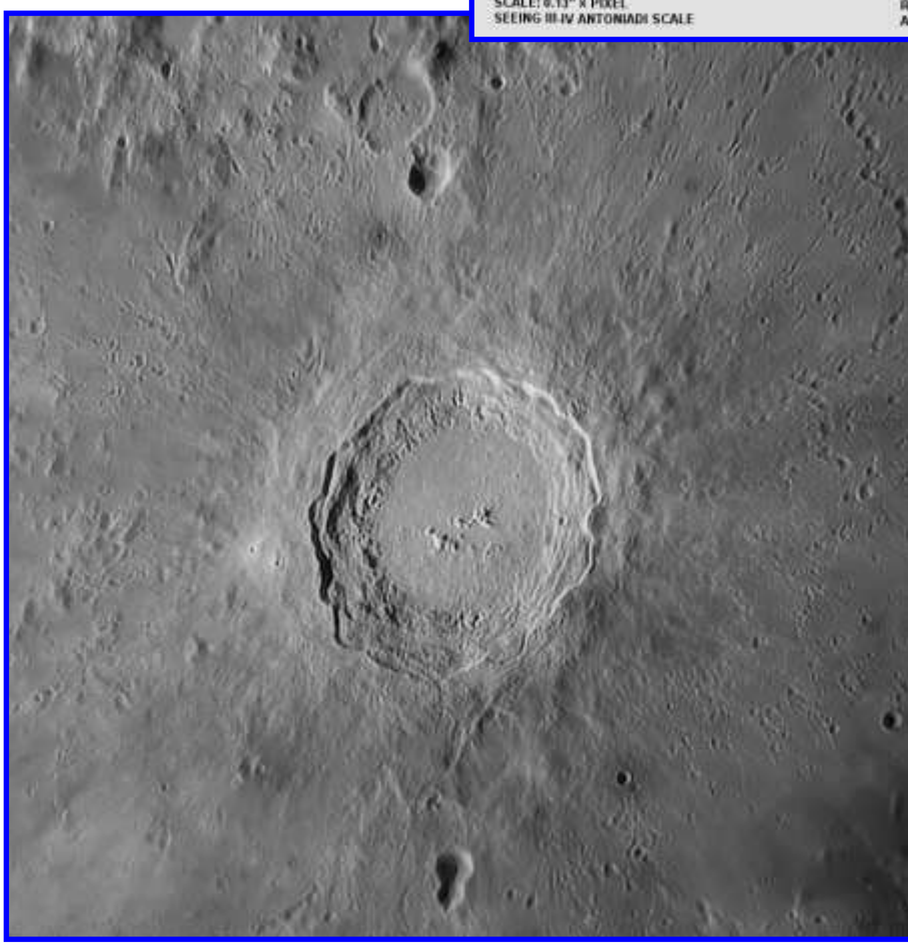


Rümker, *Massimo Dionisi, Sassari, Italy. 2023 September 27 18:46 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

De Sitter, *István Zoltán Földvári, Budapest, Hungary. 2023 October 03 01:17-01:37 UT, colongitude 131.3°. 127 mm Maksutov-Cassegrain telescope, 1,500 mm focal length, 6 mm orthoscopic, 250x. Seeing 4/10, transparency 5/6.*

Recent Topographic Studies

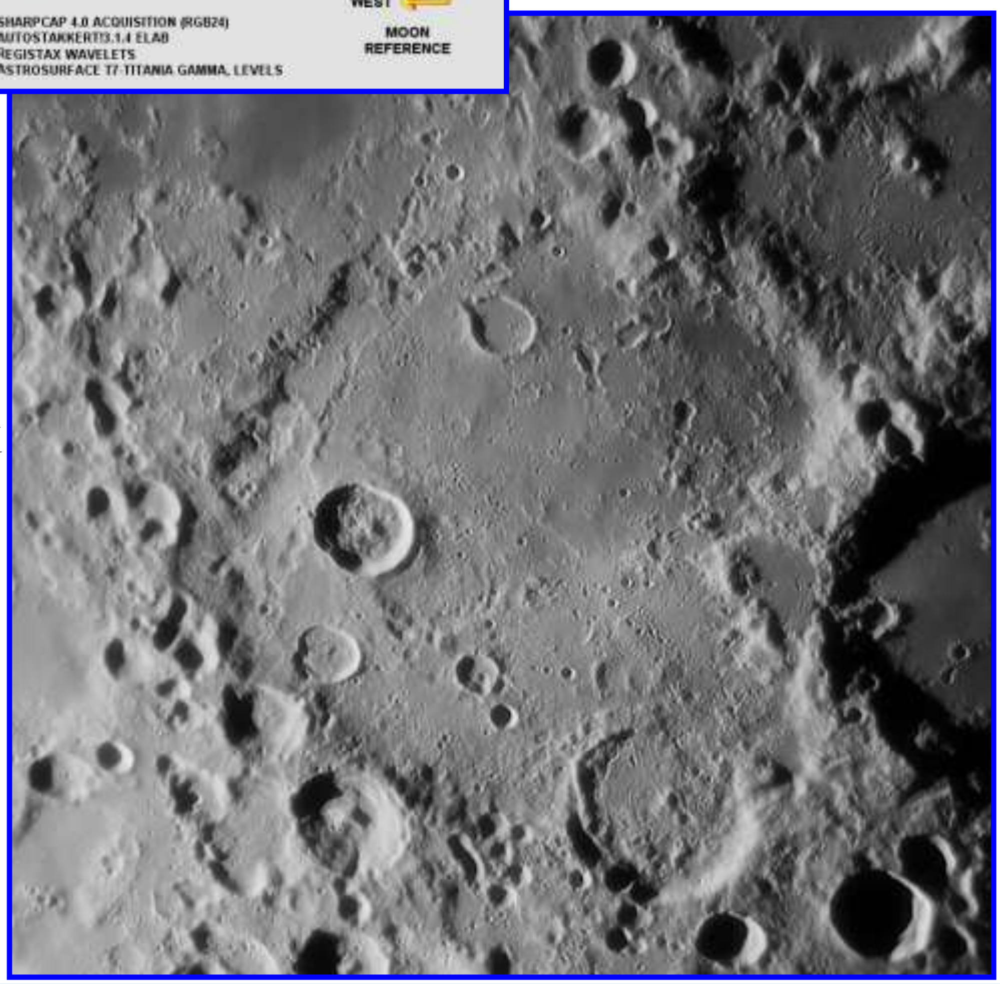
Marius, *Massimo Dionisi, Sassari, Italy. 2023 September 27 19:08 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Copernicus, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:43 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

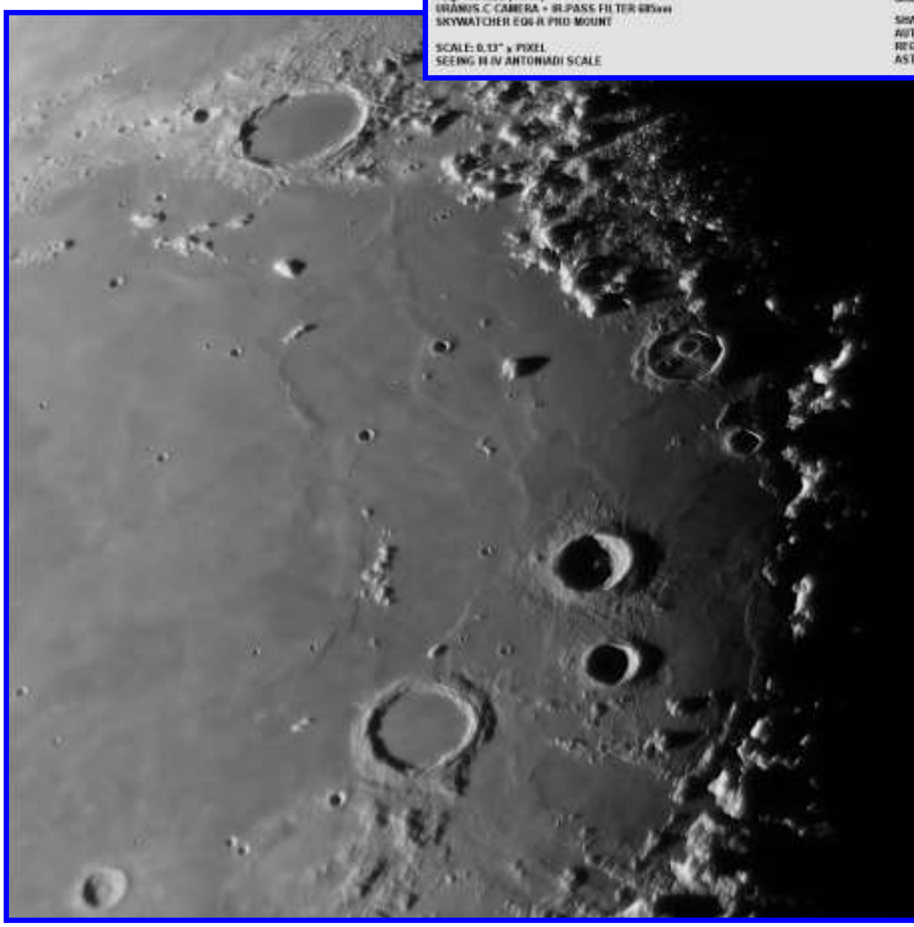
Billy, *Massimo Dionisi, Sassari, Italy. 2023 September 27 19:39 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Deslandres, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 12:03 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

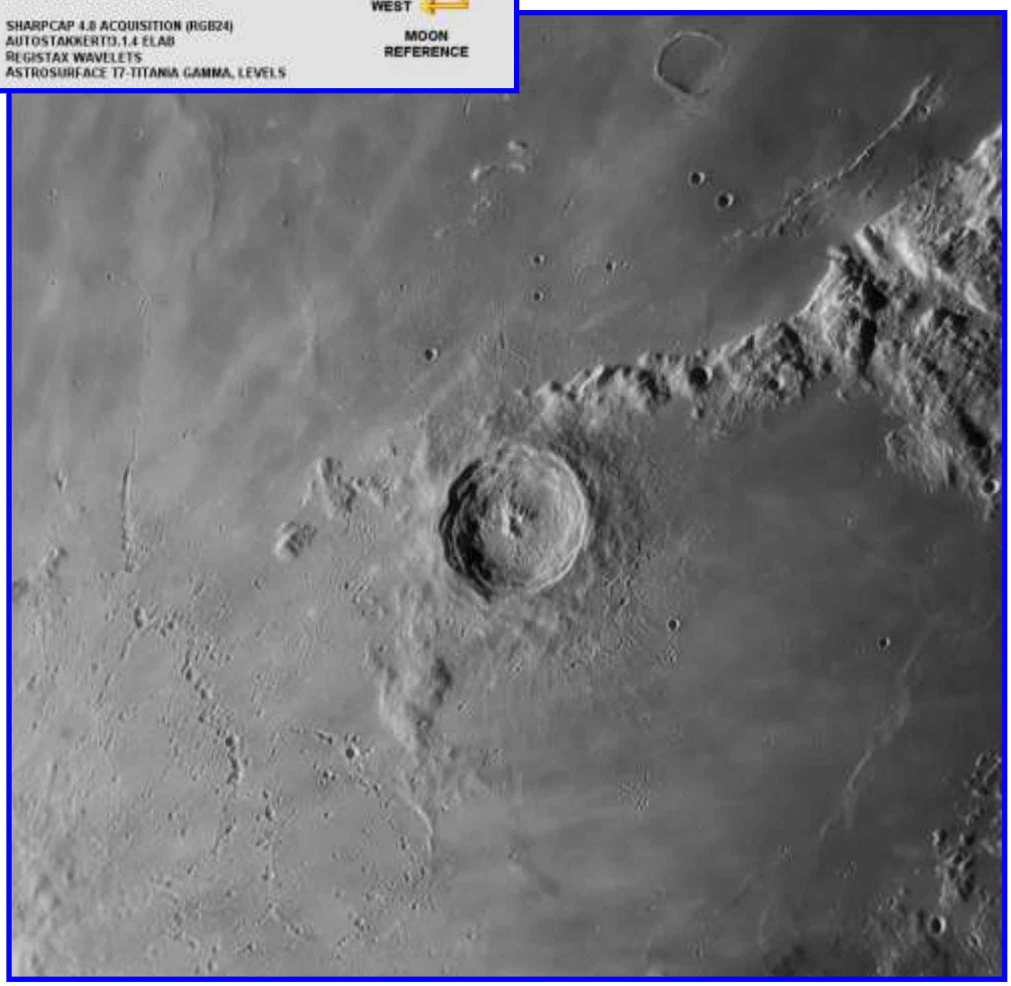
Reiner, *Massimo Dionisi, Sassari, Italy. 2023 September 27 19:18 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Eastern Mare Imbrium, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:31 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

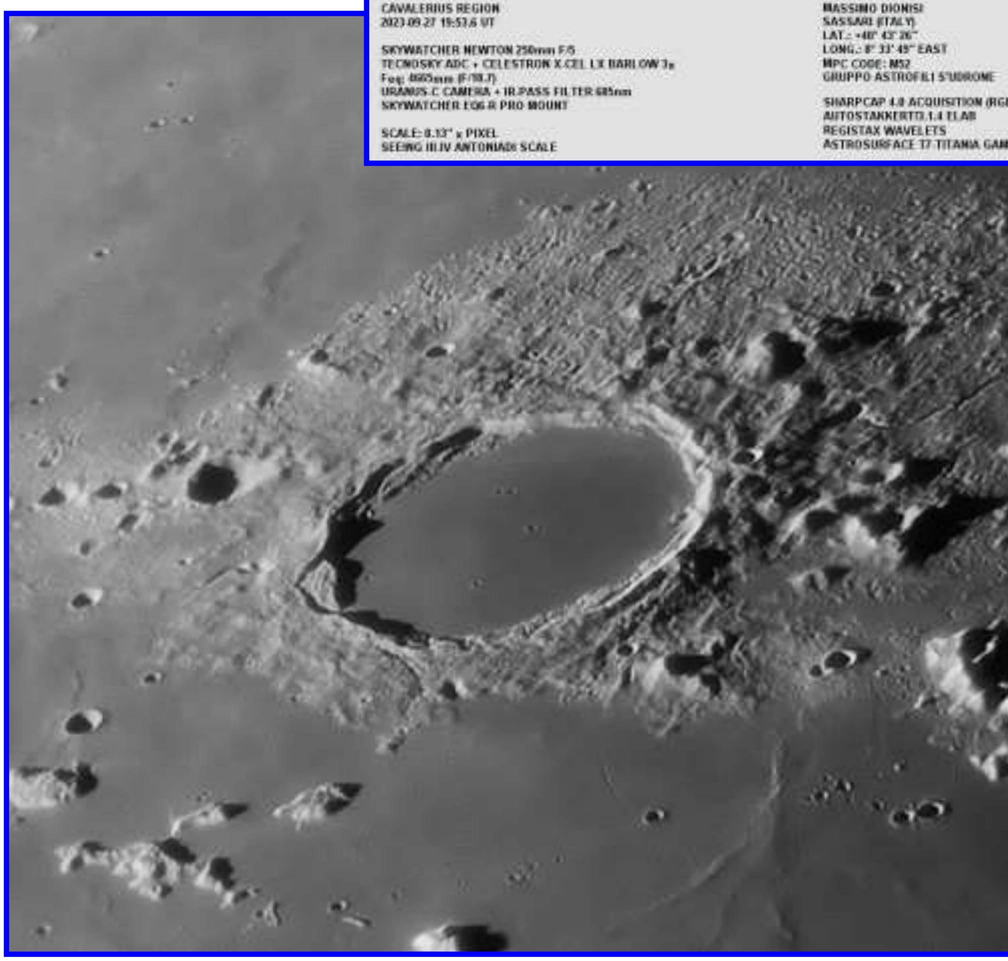
Gassendi, *Massimo Dionisi, Sassari, Italy. 2023 September 27 19:45 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Eratosthenes, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:20 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

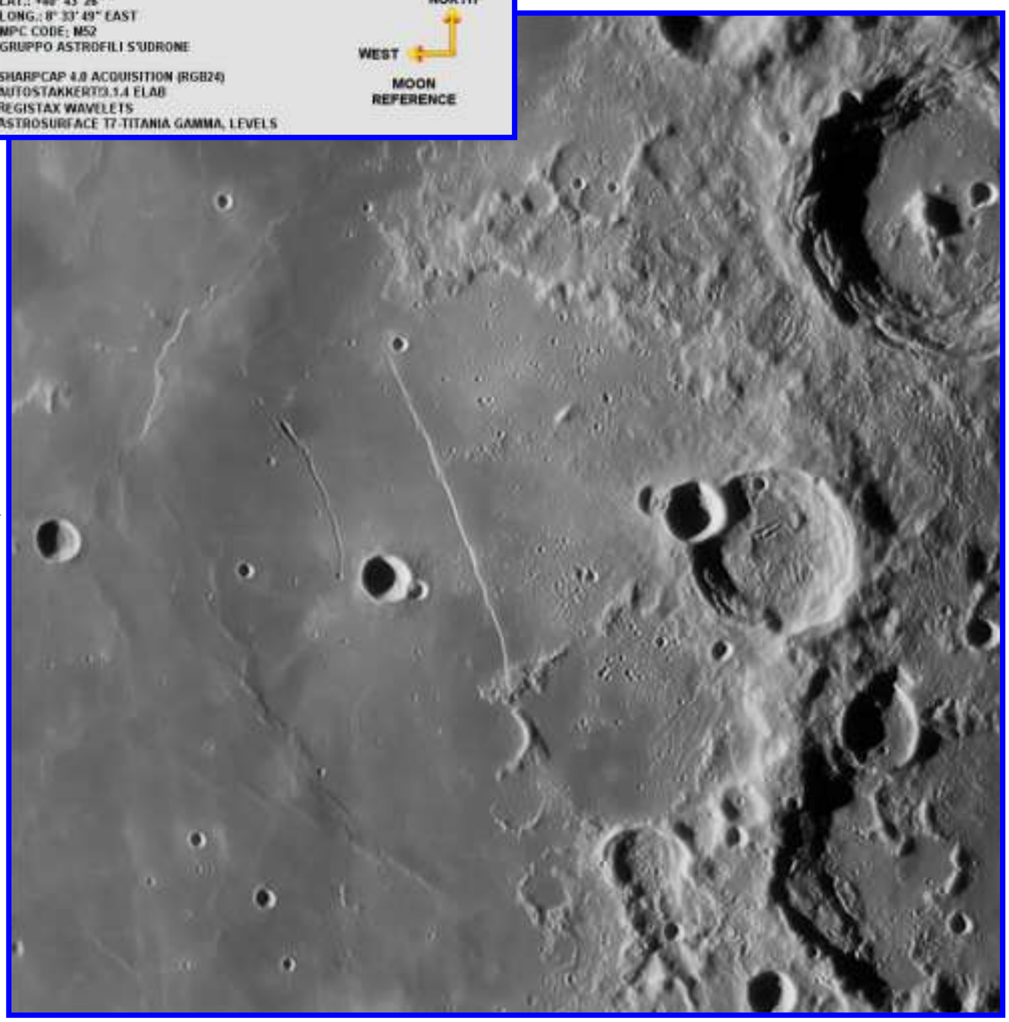
***Cavalerius,** Massimo Dionisi, Sassari, Italy. 2023 September 27 19:53 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



***Plato,** Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:28 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

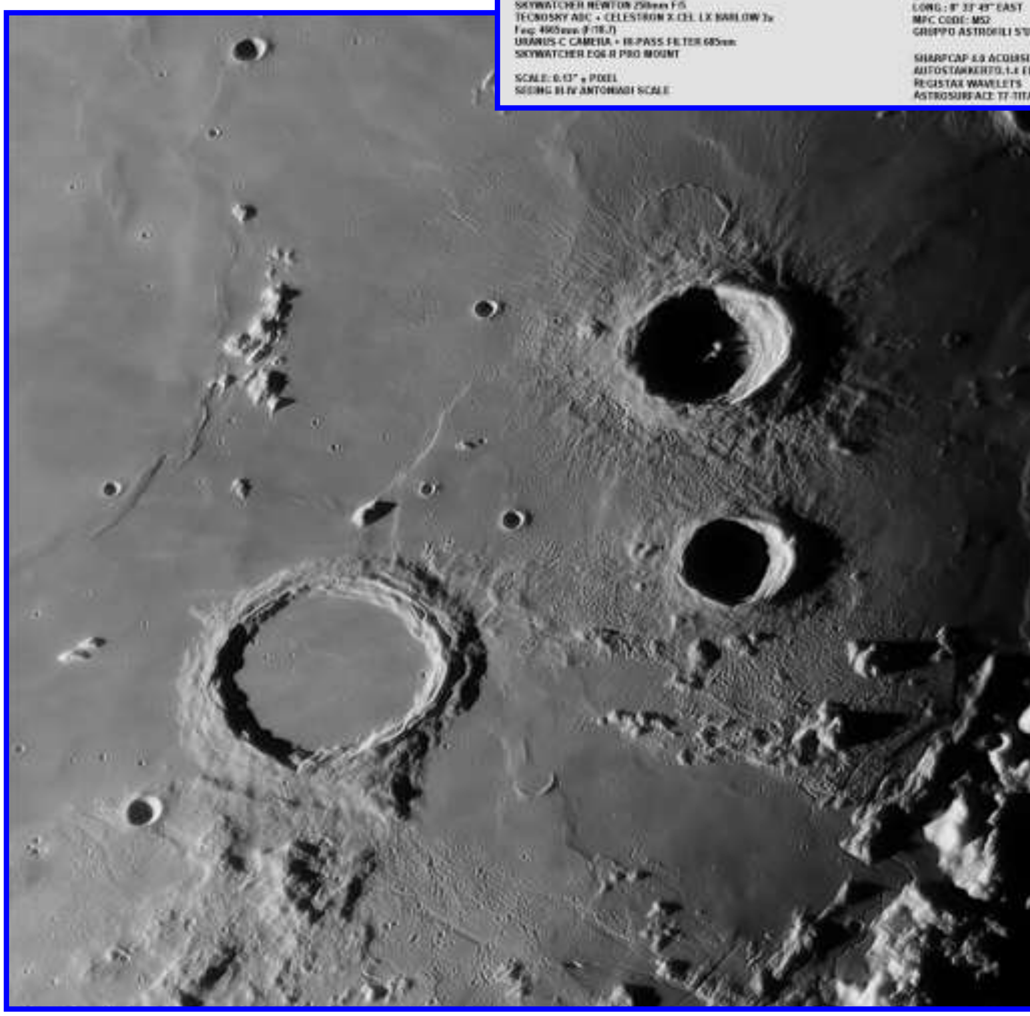
Messala, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:22 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 5,860 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Rupes Recta, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 12:00 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

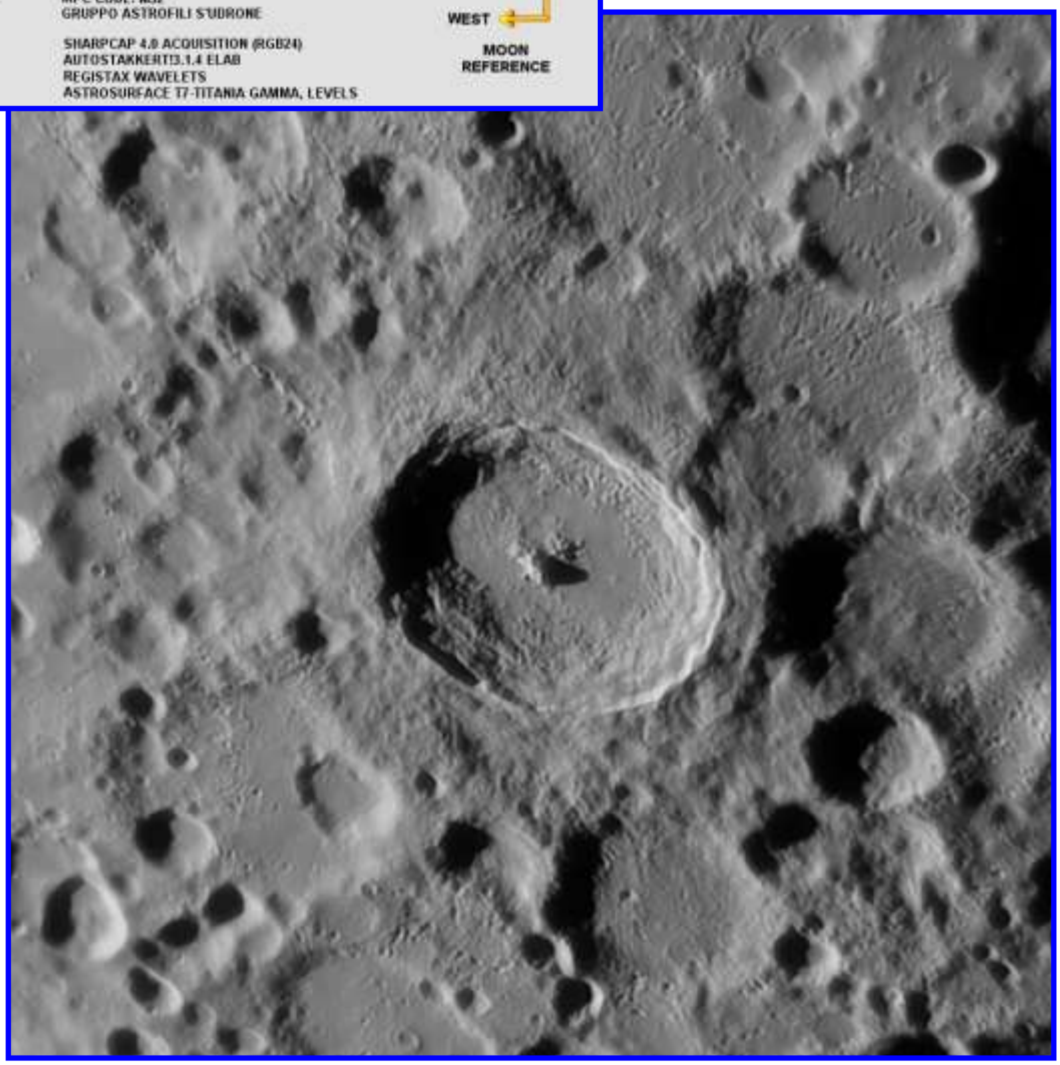
Atlas and Hercules, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:16 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



The Three A's, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:39 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

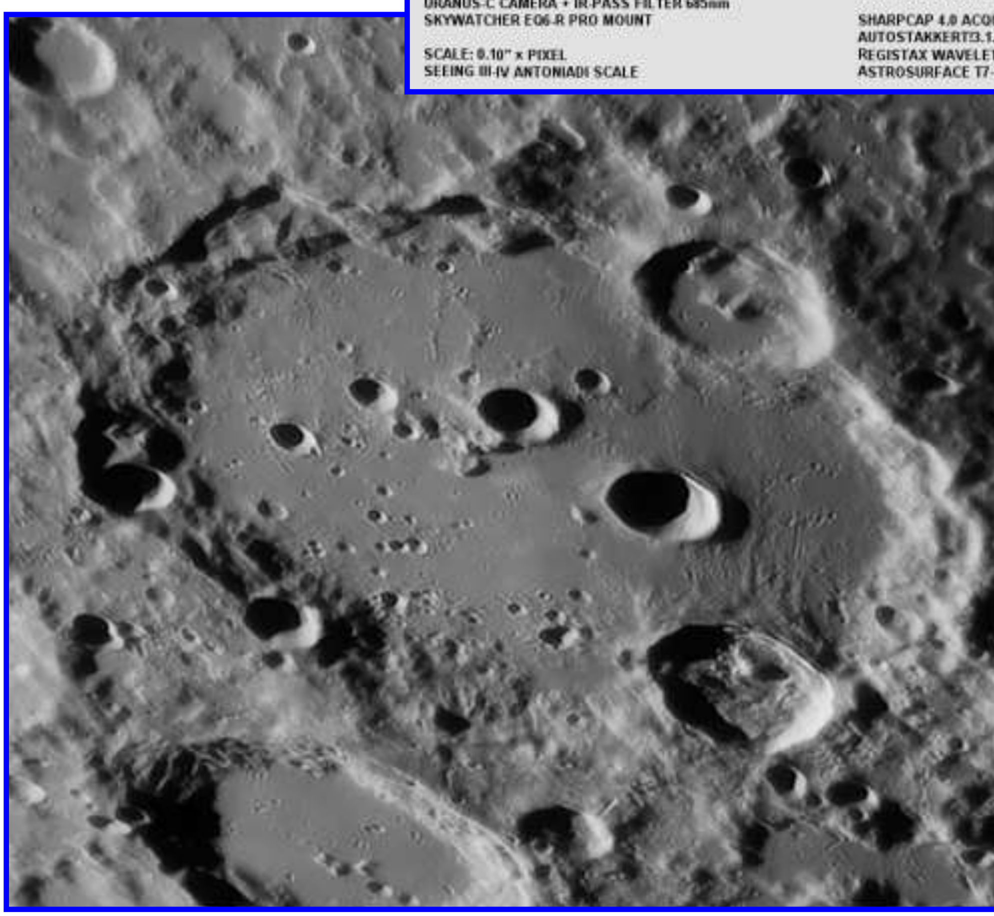
Recent Topographic Studies

Cleomedes, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:26 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



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

Yerkes, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:32 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 5,860 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Clavius, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 12:15 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

Recent Topographic Studies

Endymion, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:10 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Tycho*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:41 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

Recent Topographic Studies

Atlas and Hercules, *Massimo Dionisi, Sassari, Italy. 2023 October 02 22:16 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Clavius*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:40 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

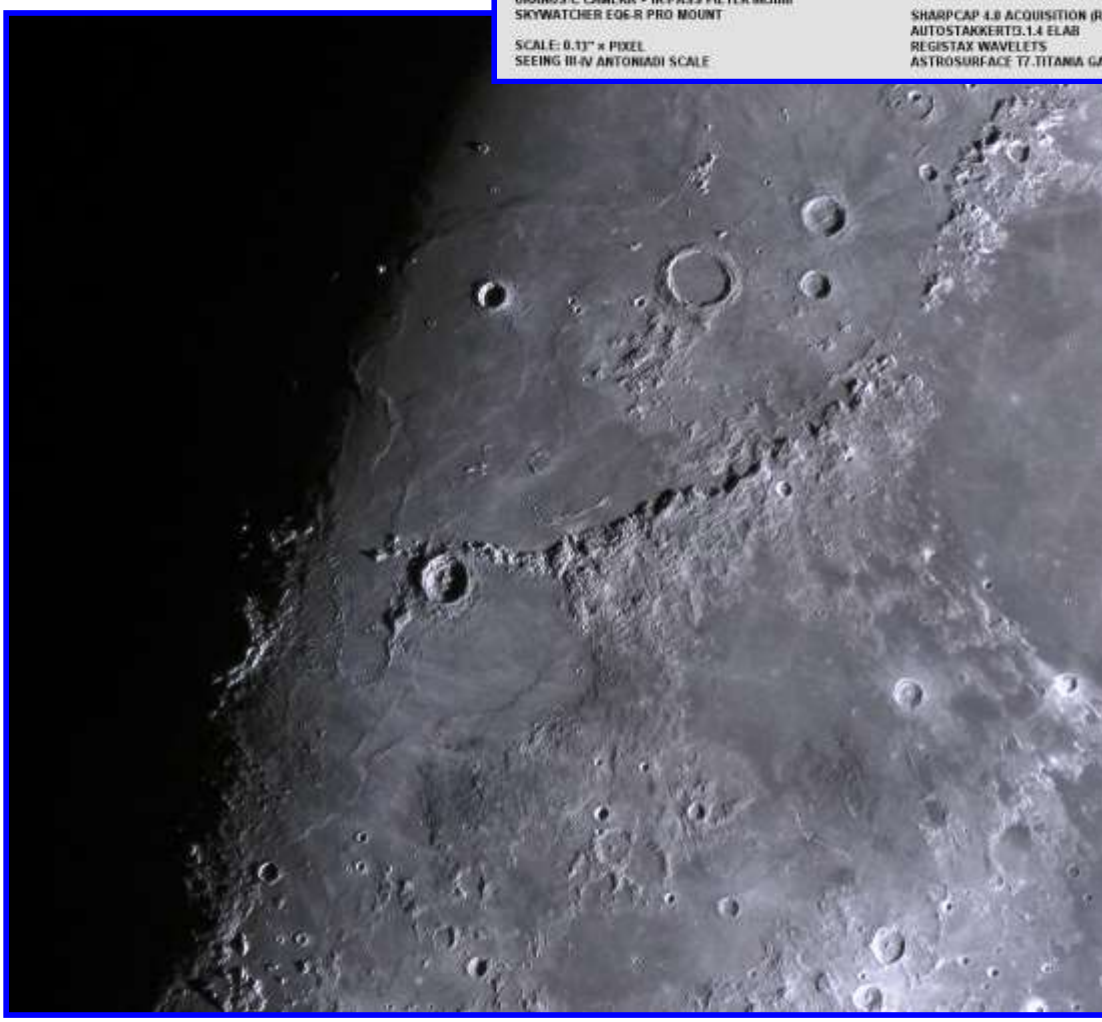
Recent Topographic Studies

Messier, *Massimo Dionisi, Sassari, Italy. 2023 October 02 22:04 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Plato*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:43 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

Recent Topographic Studies

Taruntius, *Massimo Dionisi, Sassari, Italy. 2023 October 02 22:10 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



Copernicus, *Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:39 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

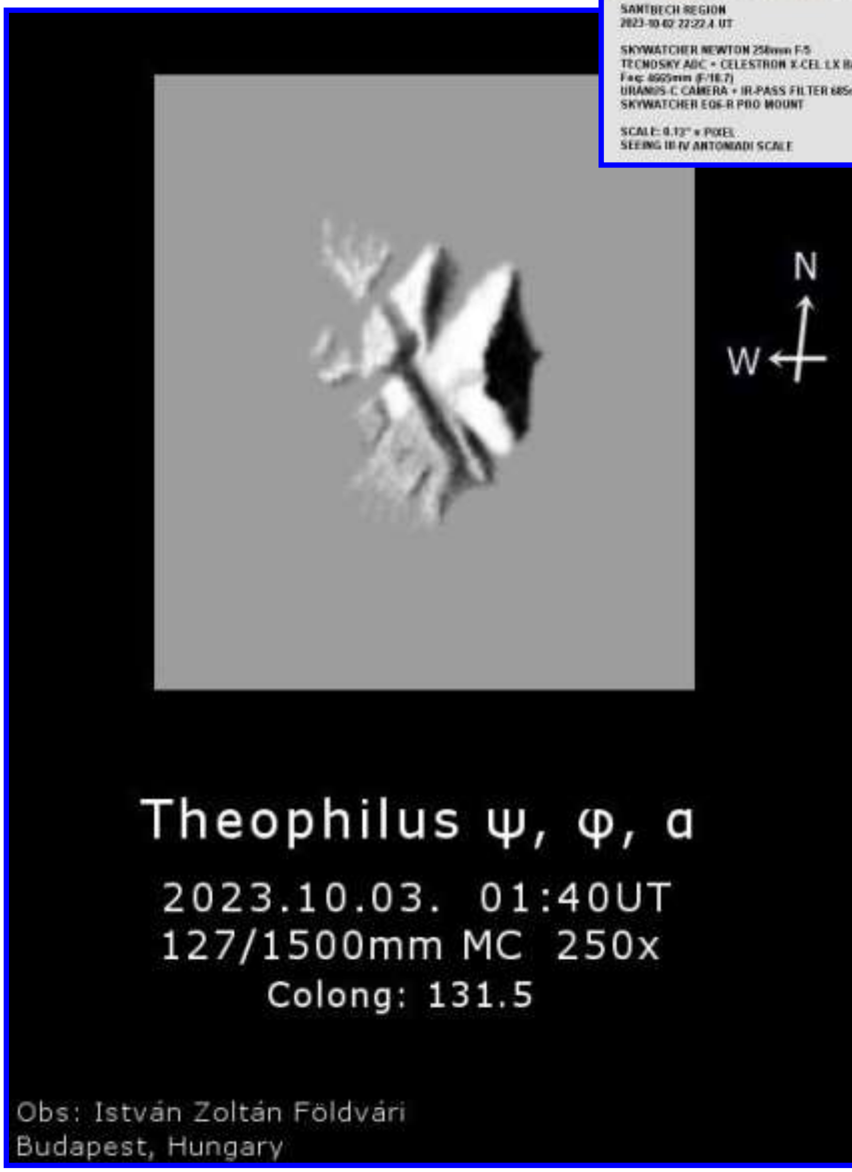
Recent Topographic Studies

Mare Fecunditatis, *Massimo Dionisi, Sassari, Italy. 2023 October 01 20:40 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 5,860 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Gassendi, *Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 26 23:58 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies

***Santbech,** Massimo Dionisi, Sassari, Italy. 2023 October 02 22:22 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



***Theophilus ψ, φ and α,** István Zoltán Földvári, Budapest, Hungary. 2023 October 03 01:38-02:00 UT, colongitude 131.5°. 127 mm Maksutov-Cassegrain telescope, 1,500 mm focal length, 6 mm orthoscopic, 250x. Seeing 4/10, transparency 5/6.*

Recent Topographic Studies

Janssen, *Massimo Dionisi, Sassari, Italy. 2023 October 02 22:27 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

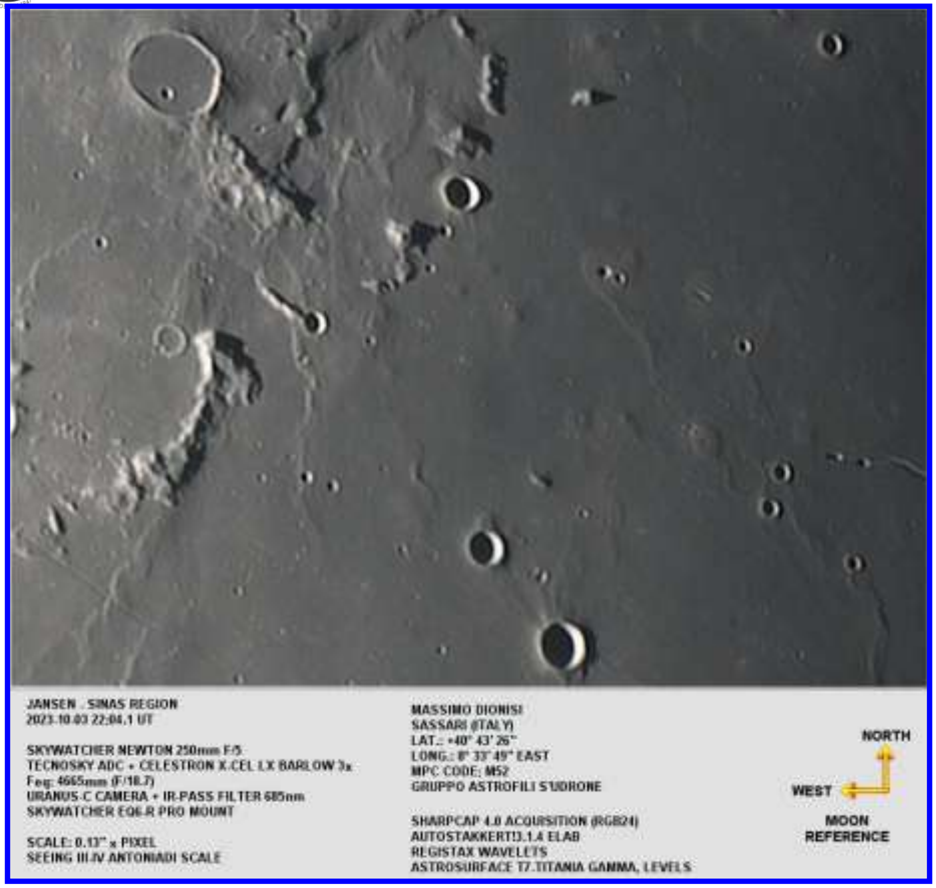
Aristoteles*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:31 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

Recent Topographic Studies

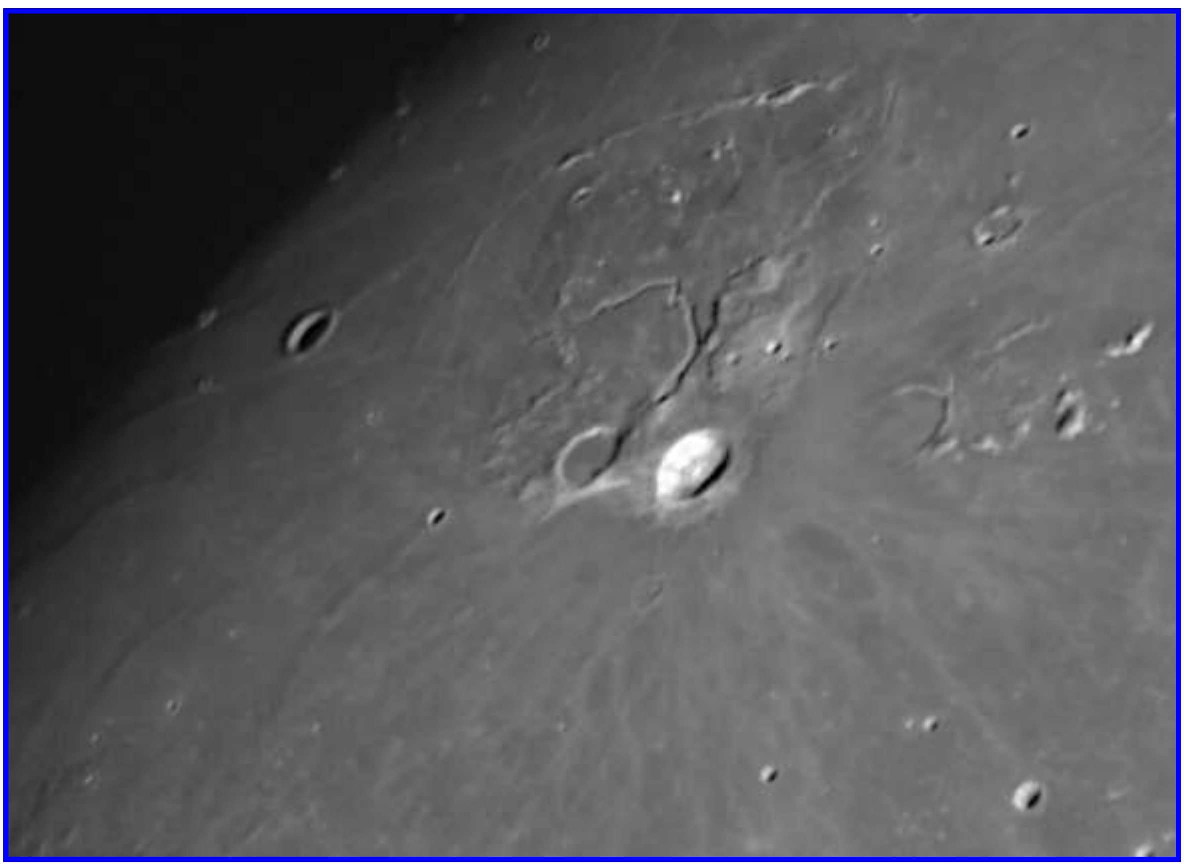
Vitruvius, *Massimo Dionisi, Sassari, Italy. 2023 October 03 21:58 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Alphonsus*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:41 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera.*

Recent Topographic Studies



***Jansen,** Massimo Dionisi, Sassari, Italy. 2023 October 03 22:04 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*



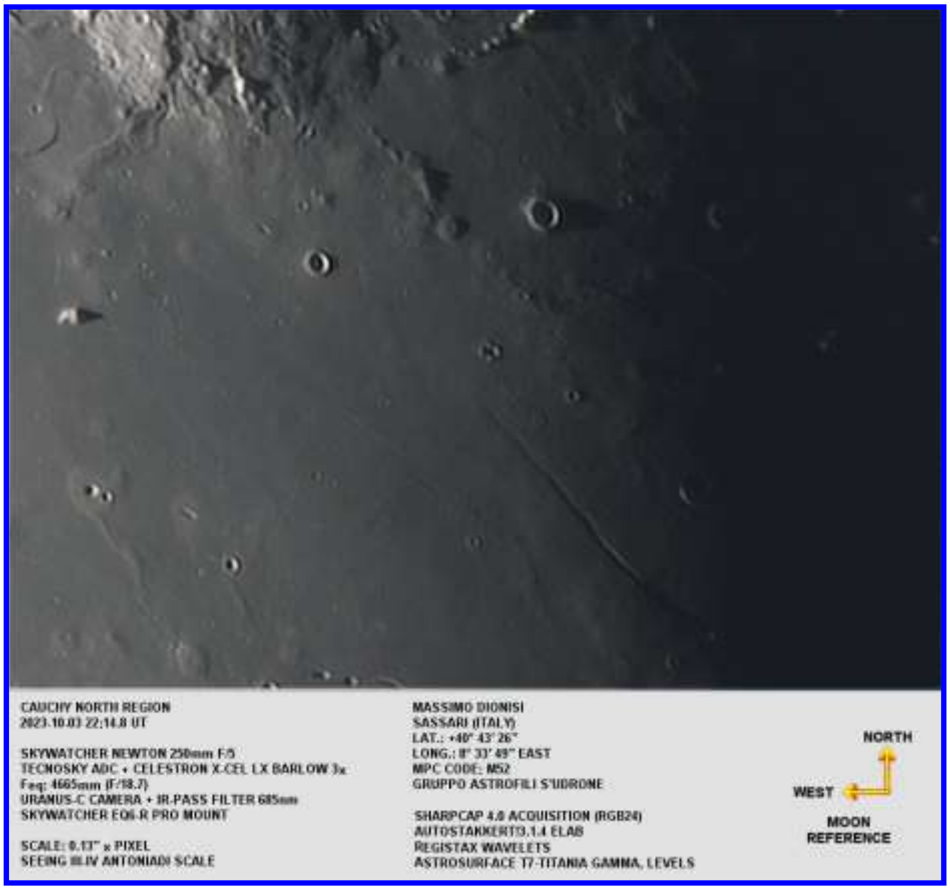
***Aristarchus,** Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 00:07 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies

Cauchy south, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:11 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Prinz, *Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 02:09 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies



Cauchy north, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:14 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Aristarchus, *Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 02:14 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies

Maraldi, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:20 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Sirsalis, *Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 03:03 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies

Fracastorius, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:33 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Archimedes, *Walter Ricardo Elias, Oro Verde, Argentina, Oro Verde Observatory AEA. 2023 October 27 02:12 UT. Celestron CPC1100 11 inch Schmidt-Cassegrain telescope, ZWO ASI120mm/s camera.*

Recent Topographic Studies

Sinus Amoris, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:24 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

Below, from Walter Ricardo Elias, Oro Verde, Argentina. Walter writes: "I attach photos taken last night... with the Celestron CPC 1100 telescope from the Oro Verde Observatory. We took the shots during the visit of students from the IPET Nº71 Luis F Leloir school in the town of Hernando, Province of Córdoba. I attach a photo of the group of students with their teachers."

Recent Topographic Studies

Gärtner, *Massimo Dionisi, Sassari, Italy. 2023 October 03 22:45 UT. Skywatcher 10 inch f/5 Newtonian reflector telescope, Tecnosky ADC, Celestron X.cel LX Barlow 3x, fl 4,665 mm, IR Pass filter 685 nm, Uranus C camera. Seeing III-IV Antoniadi Scale.*

13.6-day old Moon*, Maurice Collins, Palmerston North, New Zealand. 2023 October 28 07:43-07:52 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera. North is down, west is right.*

Recent Topographic Studies

Ptolemaeus, *Ken Vaughn, Cattle Point, British Columbia, Canada. 2023 October 06 11:55 UT. 12 inch Meade LX200 GPS Schmidt-Cassegrain telescope, Astronomik 642 R-IR filter, ZWO ASI178 MM camera. Seeing 5/10, transparency 5/6.*

6.6-day old Moon*, Maurice Collins, Palmerston North, New Zealand. 2023 October 21 07:33-07:41 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera. North is down, west is right.*

Recent Topographic Studies

Montes Apenninus, *Jairo Chavez, Popayán, Colombia. 2023 September 23 01:37 UT. 311 mm truss tube Dobsonian reflector telescope, MOTO E5 PLAY camera. North is left, west is down.*

Petavius, *Fernando Sura, San Nicolás de los Arroyos, Argentina. 2023 October 01 04:23 UT. 127 mm Maksutov-Cassegrain telescope, Samsung A22 cell phone camera.*

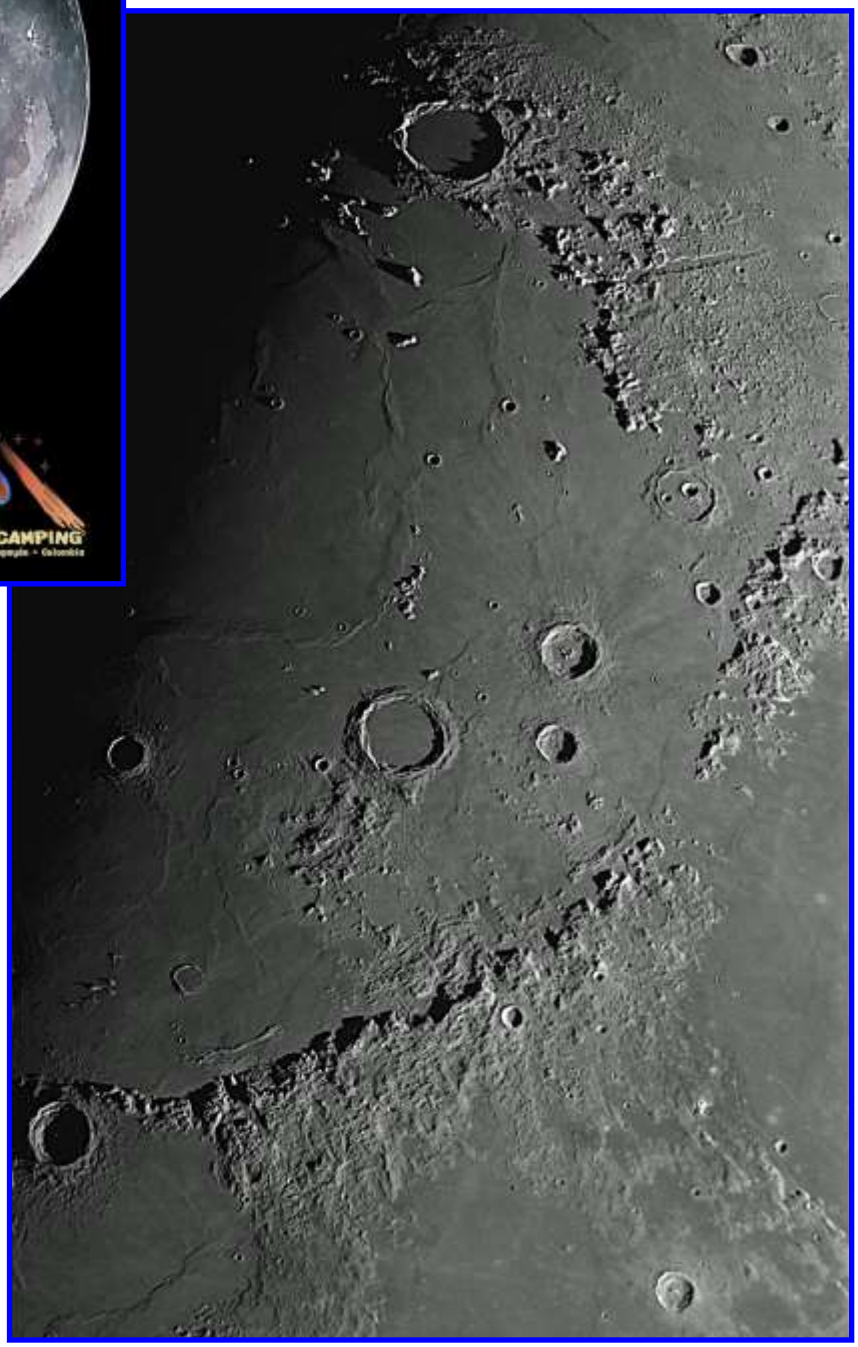
Recent Topographic Studies

72% Waxing Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2023 September 24 23:06 UT. 311 mm truss tube Dobsonian reflector telescope, MOTO E5 PLAY camera. North is down, west is right.*

8.6-day old Moon*, Maurice Collins, Palmerston North, New Zealand. 2023 October 23 07:31-07:35 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, QHY5III462C camera. North is down, west is right.*

Recent Topographic Studies

Waning Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2023 September 30 03:16 UT. 311 mm truss tube Dobsonian reflector telescope, MOTO E5 PLAY camera. North is down, west is right.*



Mare Imbrium, Katie Anderson, Detroit, Michigan, USA. 2023 October 23 01:29 UT. Celestron 8 inch Schmidt-Cassegrain telescope, ZWO ASI178MC camera. Katie adds: "This was actually an unplanned shot taken before my planned observations for the night! After alignment I slewed to the moon to check the accuracy and get rough focus. The slew stopped on an interesting looking area and my focus was great so I captured some frames before moving on to Jupiter. It took me a few days to get around to processing it, but I'm very glad I did!

My favorite feature is the shadow on the floor of Plato. With those long shadows showing off the profile of the mountainous rim you can almost imagine the view of the sun rising over them. Other features I've taken my time looking at are the well-resolved rille in the Alpine Valley and the ghost crater north of Aristillus.

It was also a lot of fun matching features in photos of Apollo 15 to my image."

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 November

News: I've been contacted by Dr Peter Thejll, a climate scientist of the Danish Meteorological institute, in Copenhagen, Denmark. He has been running a research project for at least a decade now to study reflected light from the Earth's entire surface, utilizing observations of the brightness of earthshine. Much of this includes regular images captured from a telescope in Mona Loa, Hawaii. However, with earthshine being only visible when the Moon is not too far above the horizon, time coverage is limited. Since August he is being supplied by images of earthshine taken on board the International Space Station, and this has an approximately 90 minute orbit, so the Moon is not always in the right position to photograph continuously. Peter is now asking for help from amateur astronomers, via a European Space Agency (ESA) project:

https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Illuminating_Earth_s_shine

I have copied (word for word) the text contents of the above web site into this article and would like to ask for any of our members with DSLR cameras or wide field imaging telescopes to participate:

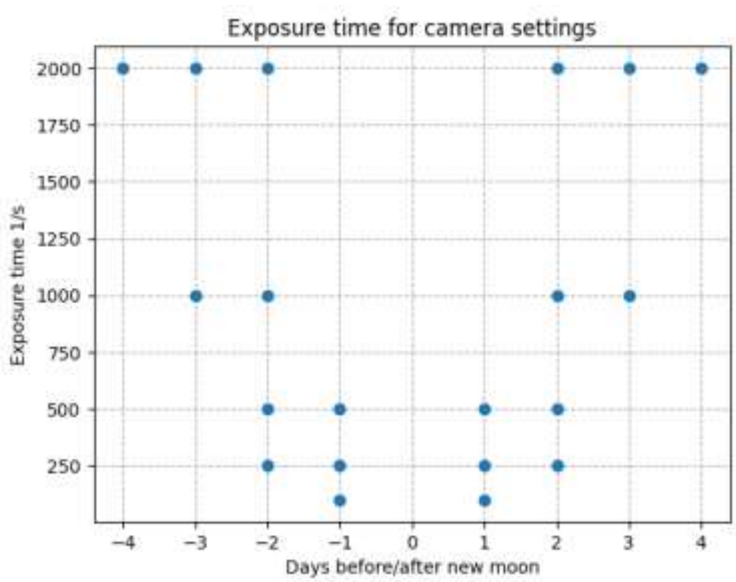


Figure 1. A graph showing which exposure settings to use for taking pictures of the new moon phase with ISO set to 4000.

*"As part of the experiment, ESA and DMI invite the public to take their own pictures of the new Moon and share them using the hashtags **#NewMoonSnap** and **#Huginn** in their social media posts. The scientists are hoping that despite some atmospheric disturbances, a substantial amount of people capturing pictures could provide valuable contributions.*
"We want to engage people in our climate science and with Andreas on the Space Station, people can help us from the ground" says Thejll. Each month, a photo posted with the two hashtags will be selected and receive a Huginn mission patch

The new Moon is best photographed using a good quality digital camera. If you are in a pinch, your mobile phone can work. It is recommended to use the 'Professional' or 'Pro' mode in your camera app as it provides more options for the settings.
To take good photos and help the scientists, here are the settings that should set your camera up for success:

- *On your camera, set the file format to RAW or NEF, if possible.*
- *Set ISO to 4000 and the f-stop to f/2.8*
- *Exposure should be between 1/2000 to 1/250 s, see the graph in the article for what exposure to use on which day.*
- *Keep the Moon centred in the frame.*

If possible, use a telephoto lens.
It is best to take photos after sunset, or in the morning before sunrise. Here are the days throughout the Huginn mission that would be best for taking photos of the new moon:

- *14 to 18 August 2023*
- *13 to 17 September 2023*
- *12 to 16 October 2023*
- *11 to 15 November 2023*
- *11 to 15 December 2023*
- *9 to 13 January 2024*

8 to 12 February 2024"
N.B. Apart from adding social media Hashtags for the project to find, please email in your images of earthshine so that we may keep a backup copy in the ALPO/BAA archives. These could be useful, for example, to monitor the brightness of LTP Aristarchus over time.
Note that suggested observing times, on the web site, are limited to just a few cities. Peter recommends imaging earthshine if you can see it on the dates concerned.
LTP Reports: No LTP or impact flash reports were received for September.

Routine reports received for September included: Maurice Collins (New Zealand - ALPO/BAA/RASNZ) imaged: Aristarchus, and several features. Anthony Cook (Newtown, UK – ALPO/BAA/NAS) imaged/videoed: several features & earthshine in the Short-Wave IR. Walter Elias (Argentina – AEA) imaged: Aristarchus. Massimo Giuntoli (Italy – BAA) observed Cavendish E. Michael Hather (Sheffield, UK – BAA) observed Aristarchus, Gassendi, Plato, Posidonius and several features. Bob Stuart (Rhayader, UK – BAA) imaged: Alfraganus, Delambre, Dionysius, Mons Penck and Theophilus.

Analysis of Reports Received (September): It seems that most people have been affected badly by weather this month in both hemispheres of our planet!

Cavendish E: On 2023 Sep 01 UT 21:00 Massimo Giuntoli (BAA) found that the crater had a normal appearance. A 12.7 cm f/7 Newtonian used at x180 and seeing was Antoniadi IV.

Aristarchus: On 2023 Sep 04 UT 02:30-02:50 Michael Hather (BAA) observed visually this crater, some 5 minutes before the following repeat illumination observing window opened:

Near Aristarchus 1970 Mar 26 UT 17:00 Observed by Sekiguchi, Maisumoto (Tokyo, Japan, 36" reflector) "Pts. N & S of crater were brighter by 0.3 & 0.2 mag. respectively than normal -- far beyond limits of error. Color index (CI) also showed less depend. on phase by 0.1-0.2 mag. Did not show reddening dur. enhancement. Polariz. was less by 1-2%. Photog. photom. showed brightening over whole moon. Resolution = 2,3 km" NASA catalog weight=5 and catalog ID #1236. ALPO/BAA weight=3.

Michael was using a Takahashi FC-100DF, 100mm; Takahashi TOE3.3mm, x224 under Antoniadi I seeing and average transparency. He reported that the crater looked normal and nothing unusual was seen. The Maisumoto report was published in the paper: Sekiguchi, N. (1971) An Anomalous Brightening of the Lunar Surface Observed on March 26, 1970, The Moon, 2, p 423-434. We shall leave this at a weight of 3 for now.

Unknown: On 2023 Sep 05 UT 02:36 Bob Stuart (NAS/BAA) imaged a number of localized areas on the Moon under similar illumination to the following report:

On 1888 Nov 23 at 16:15-17:00 UT Von Speissen & others of Berlin, Germany, using a 3.5" refractor (x180), saw a "Triangular patch of light (time in Middlehurst catalog wrong? Moonrise was at > 18:30h. If year =1887, age=8.8 days & time OK. must be same observation as ID=256 in Cameron 1978 catalog - note similarity of names and also the reference date). Cameron 1978 catalog ID=258 and weight=1.

Figure 2. *Theophilus and Cyrillus and imaged by Bob Stuart on 2023 Sep 25 UT 02:36 and orientated with north towards the top.*

This is an ambiguous LTP report as firstly it is not clear where the triangular patch was seen and secondly according to Cameron the year could have been 1887 or 1888. Bob was imaging under similar illumination to the candidate 1888 Nov 23 hypothesis. Out of all Bob's images of: Alfraganus, Delambre, Dionysius, Mons Penck and Theophilus, only the Theophilus one (Fig 2) exhibits some triangular patch of light in the form of three peaks in the central peak area of Theophilus. However, reading Cameron's account carefully, she is of the opinion that it was probably 1887 Nov 23 and 20:00UT and may refer to a triangular patch on the floor of Plato? I agree with her in that if you plug in the 1888 Nov 23 UT 16:15-17:00 then the Moon is clearly below the horizon in Berlin, and does not rise till 18:58UT. If you plug in 1887 Nov 23 then the Moon is already well above the horizon at sunset. I think we will delete the 1888 Nov 23 LTP, which was reported as such in the previous Middlehurst catalog from 1967.

Figure 3: *Plato from 2014 Mar 09 – North is towards the top.* ***(Left)*** *Image by Brendan Shaw from 19:41UT.* ***(Center)*** *Sketch made by Nigel Longshaw at 19:50-20:05UT.* ***(Right)*** *Image by Brendan Shaw from 20:15UT.*

If you are interested in what Plato would have looked like in 1987 Nov 23, Fig 2 shows a copy of some repeat illumination observations published in the 2024 May LTP newsletter. It is possible that the Berlin observations may have been a bit earlier than Cameron estimates i.e., 20:00 UT, in which case you would have had a transition between an oval light area on the floor and the Fig 3 images.

Mare Crisium: On 2023 Sep 21 UT 07:09-07:12 Maurice Collins imaged the whole Moon as a mosaic under similar (±1˚) illumination, and topocentric libration to the following report:

Mare Crisium 1826 Apr 13 UT 20:00 Observed by Emmett (England?) "Black moving haze or cloud" NASA catalog weight=2. NASA catalog ID =109. ALPO/BAA weight=1.

***Figure 4:** Mare Crisium, extracted from a larger mosaic, made by Maurice Collins and taken on 2023 Sep 21 UT 07:09-07:12. North is towards the top.*

I have always been a bit skeptical about LTP reports that involve movement, simply because the fact that the escape velocity on the lunar surface is only 2.4 km/s, and doing a simple calculation, 1 degree at the surface of the Moon spans approximately 30 km, so anything moving faster than 30/2.4=12.5 deg/sec (at the lunar equator or along a lunar latitude line) will likely escape from the Moon unless it is on a shallow trajectory. Now we do not know how fast the cloud was moving. Mare Crisium spans 550km E-W and 400km N-S, so if something was moving at escape velocity it would cover the mare interior in 3.8 and 2.8 min respectively. Now the Emmett report does not specify what rate the cloud moved or expanded it. It is possible that it might have been ejecta from an impact event, but that would have had a bright flash followed by an increasingly enlarging ejecta cloud which would fade out radially. If the impact were near parallel to the surface, then the expanding cloud would be more directional, but again would fade out. Such clouds from impacts tend to be fairly translucent, and unlikely to appear "black" or cast a strong shadow. Another possibility, again without knowing much detail about the original report, is that it could simply be a cloud in our atmosphere going across the Moon in the line of sight. Of course, an experienced observer would not be fooled by this so easily. So, for now we shall leave the weight at 1. At least we know what Emmett would have seen at Mare Crisium on that night in 1826 if everything had been normal, namely what we see in Fig 4.

Aristarchus Area: On 2023 Sep 27 UT 23:42 Walter Elias (AEA) imaged this crater under similar illumination to the following two reports:

Aristarchus observed by P. Moore on 1995-11-5 Color seen between Aristarchus and Herodotus by P. Moore and G. North. ALPO/BAA weight=3.

Vallis Schroteri - On 1994 Apr 24 at UT 03:50 R. Manske (Waunakee, WI, USA) found that the Cobra Head appeared to have an obscuration on the top eastern half. The ALPO/BAA weight=2.

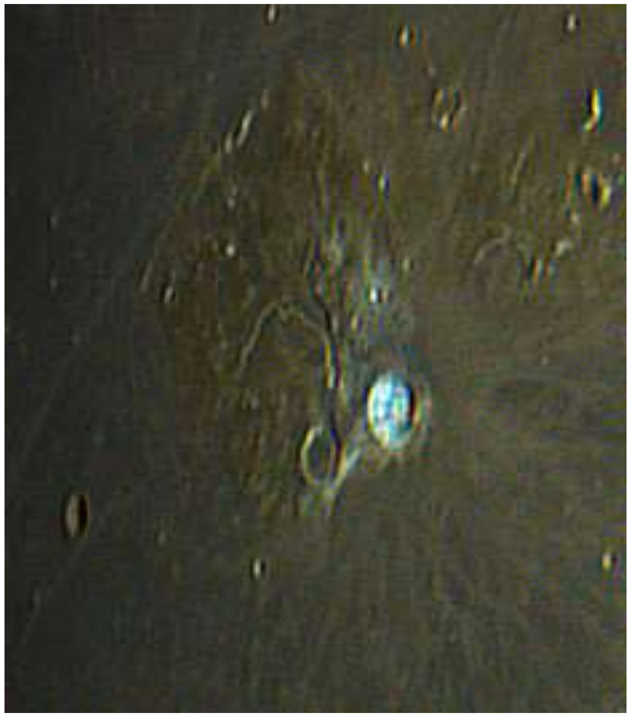


Figure 5: *An image of Aristarchus taken by Walter Elias on 2023 2023 Sep 27 UT 23:42 and orientated with north towards the top. Note that the color saturation has been enhanced to make colors more pronounced than you would see normally visually.*

Walter's image (Fig 5) shows no obvious sign of color between Aristarchus and Herodotus, and nor any obscuration on the top eastern half of the Cobra's Head. Therefore, we shall leave the weights of these LTP reports as they were. It is interesting though that the Cobra Head crater has a slight pinkish cast to it, but so do some other small craterlets, and so it is most likely atmospheric spectral dispersion?

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

No images or sketches have been sent in specifically for the BBC project, taken during October, nor any armchair work done at the computer, so I thought that I would pick another candidate buried crater from the catalog, and look at evidence for there being a crater there, or not? So this month's buried crater is: PFC 32, which is located at 42.5˚W 10.6˚S with a diameter of 111 km.

Just to remind the reader, PFC stands for "Partly Filled Crater". The PFC's listed come from the paper by: A.J. Evans, J. M. Soderblom, J. C. Andrews-Hanna, S. C. Solomon, and M. T. Zuber (2016), Identification of buried lunar impact craters from GRAIL data and implications for the nearside maria, Geophys. Res. Lett., 43, 2445–2455, doi:10.1002/2015GL067394.

So, let's look at the NASA Quick Map web site and see what is there at this location. The WAC nearside mosaic (with shadows) shows quite clearly 60% of a crater rim, and adding nomenclature we can see that this crater is called "Letronne" and so it is not correct to suggest that this was completely unknown, and the Evan's et al. paper should have at least mentioned its name. According to NASA Quickmap the diameter of this crater is 117.6 km, i.e., 7.6 km bigger than the catalog entry, and located at 42.5˚W 10.5˚S. The age of the oldest part of the mare fill is 3.4Ga, according to the Hiesinger Mare Age Units map on Quickmap, so therefore the crater must be older than this.

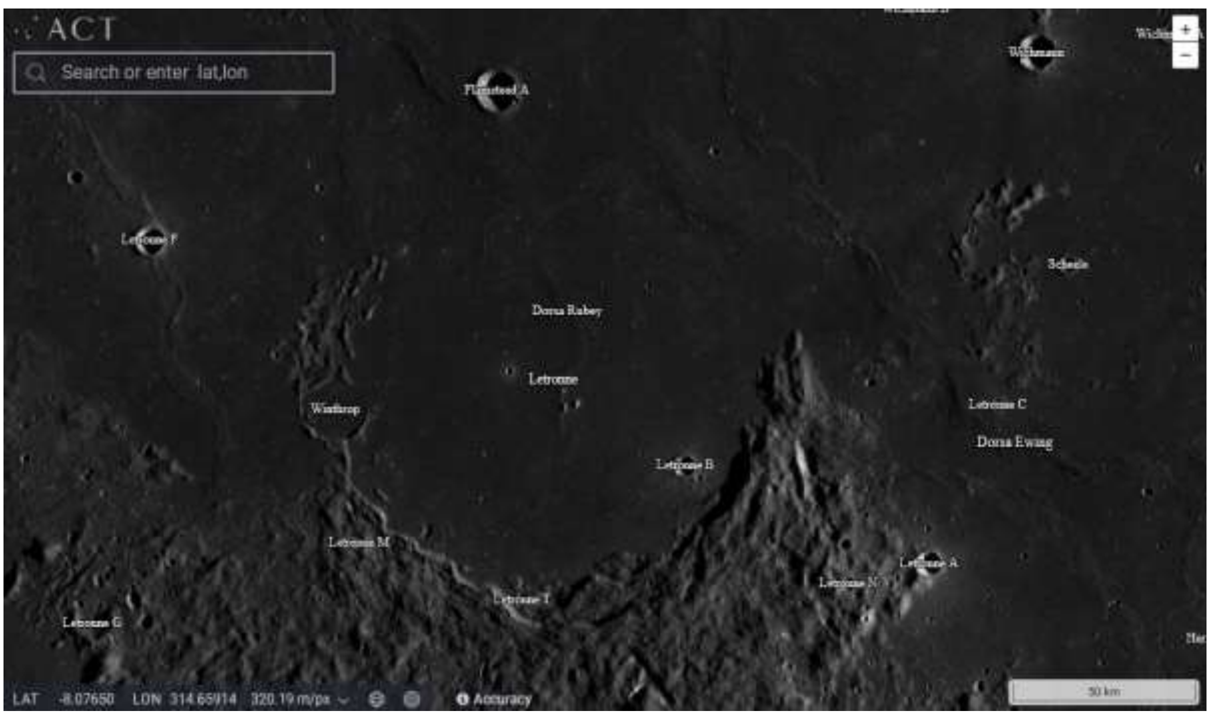


Figure 2 *LROC Quickmap WAC nearside mosaic with shadows centred on the approximate location of PFC 32. Note that the scale bar on the bottom right corner is 50 km long.*

As always, azimuth direction plots of the slope on the surface can be quite revealing. Fig 2 reveals that PFC 32's northern rim shows through the mare in Oceanus Procellarum and using this I was able to measure the diameter on 5 transects and come up with my own estimate of the diameter at 115.3 ± 2.2 km, which is a couple on kilometres smaller than the NASA LROC estimate.

As we have identified this buried crater as Letronne, and it's an IAU named crater, we can remove it from the Buried Crater list, as it is a well-known crater and perhaps should not have appeared in the Evans et al. paper.

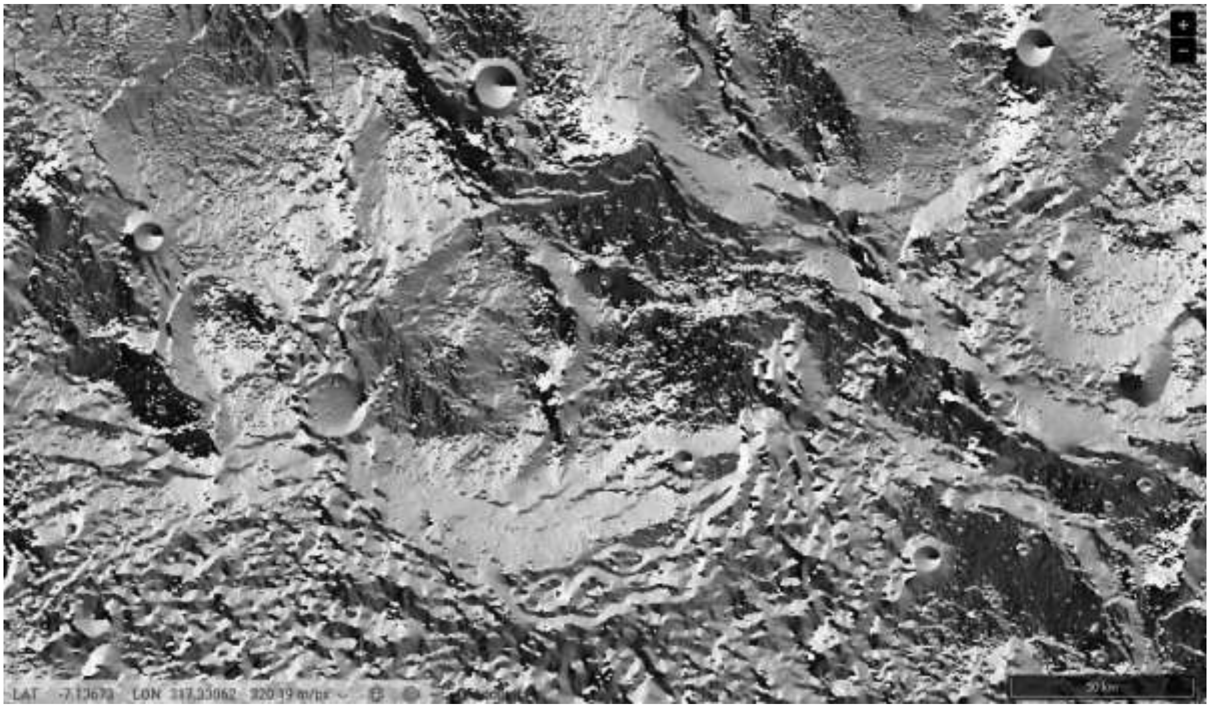


***Figure 2** LROC Quickmap ACT Layers (Experimental): Terrain Azimuth. The scale bar on the bottom right is 50 km long.*

If you think that you have discovered a new impact basin, or unknown buried crater, please check whether it has been found previously on the following web site, and if not email me its location and diameter so that I can update the list.

https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm.

Alternatively, if you want an observational challenge, try to see if you can image one of more of the basins or buried craters at sunrise/set and establish what colongitude range they are best depicted at. Or you can even do this “virtually” with LTVT software. As you can see from the tables on the web sites there are lot of blank cells to fill in on the sunrise and sunset colongitude columns – so a good opportunity for you to get busy!

Lunar Calendar November 2023

Date	UT	Event
1		East limb most exposed (+6.0°)
2		Greatest northern declination (+28.3°)
4		South limb most exposed
5	0837	Last Quarter Moon
6	2200	Moon at apogee 404,569 km
9	0900	Venus 1.0° south of Moon, occultation N Canada, Europe, N. Africa, Middle East
11	0849	Moon at descending node
13	0927	New Moon lunation 1248
14	1500	Mercury 1.7° north of Moon
14	2000	Antares 0.9° south of Moon, occultation North America to Caribbean
15		West limb most exposed (-4.8°)
17		Greatest southern declination (-28.1°)
18		North limb most exposed (+6.7°)
20	1050	First Quarter Moon
20	1400	Saturn 3° north of Moon
21	2100	Moon at perigee 369,818 km
22	0800	Neptune 1.5° north of Moon
24	1102	Moon at ascending node
25	1100	Jupiter 3° south of Moon
26	0900	Uranus 3° south of Moon
27		Moon 1.1° south of Pleiades
28	0916	Full Moon
29		East limb most exposed (+5.0°)
30		Greatest northern declination (+28.1°)

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

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

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

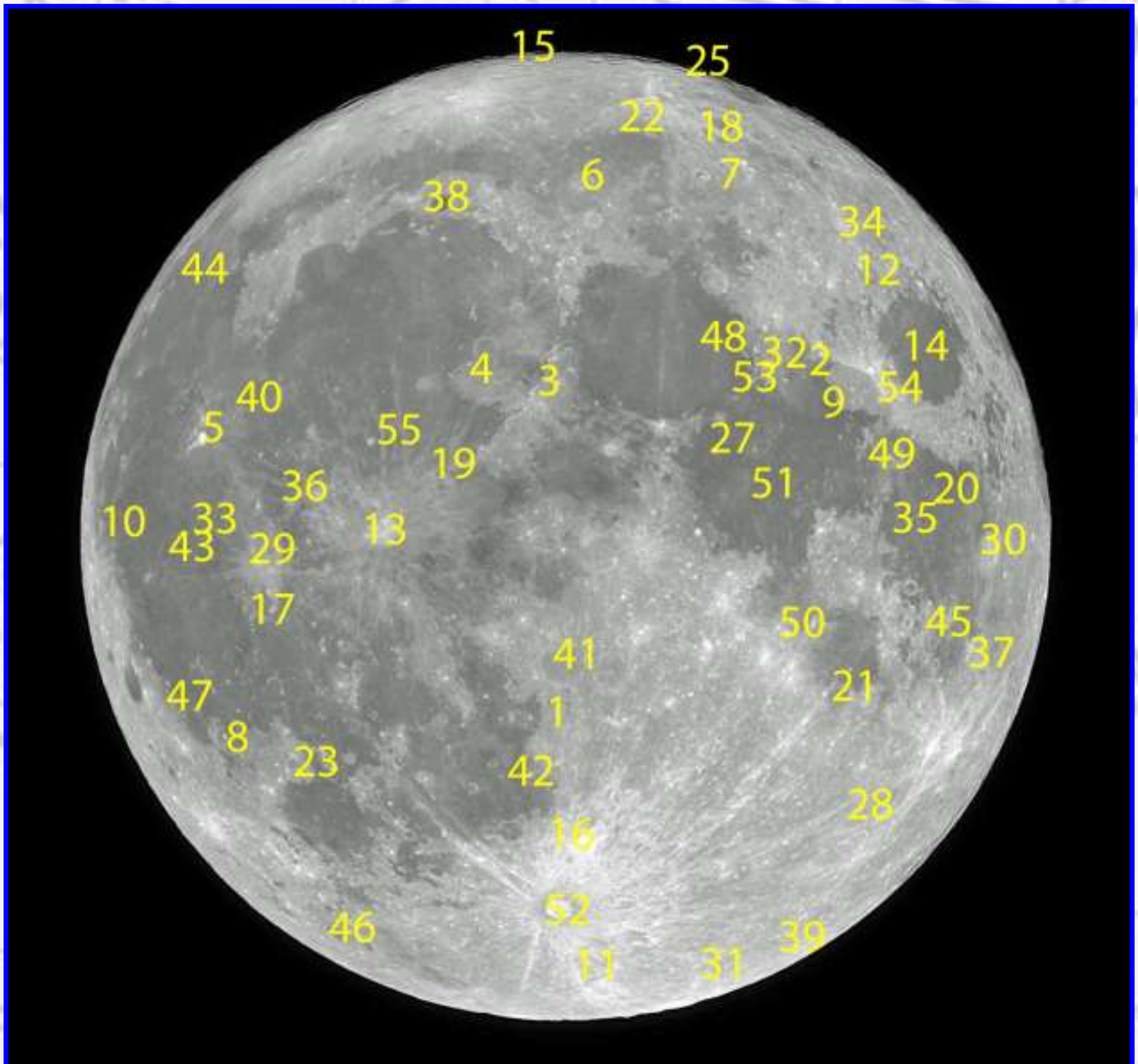
MARCH 2024 ISSUE: Due February 20, 2024: LACUS MORTIS

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

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

Larry Todd

Key to Lunar Images In This Issue



Gregory Shanos

1. Alphonsus
2. Amoris, Sinus
3. Apenninus, Montes
4. Archimedes
5. Aristarchus
6. Aristoteles
7. Atlas
8. Billy
9. Cauchy
10. Cavalerius
11. Clavius
12. Cleomedes
13. Copernicus
14. Crisium, Mare
15. De Sitter
16. Deslandres
17. Encke
18. Endymion
19. Eratosthenes
20. Fecunditatis, Mare
21. Fracastorius
22. Gärtner
23. Gassendi
24. Gruithuisen
25. Hahn
26. Imbrium, Mare
27. Jansen
28. Janssen
29. Kepler
30. Langrenus
31. Manzinus
32. Maraldi
33. Marius
34. Messala
35. Messier
36. Milichius
37. Petavius
38. Plato
39. Pontécoolant
40. Prinz
41. Ptolemaeus
42. Recta, Rupes
43. Reiner
44. Rümker
45. Santbech
46. Schickard
47. Sirsalis
48. Smirnov, Dorsa
49. Taruntius
50. Theophilus
51. Tranquillitatis, Mare
52. Tycho
53. Vitruvius
54. Yerkes
55. Zirkel, Dorsum