The Lunar Observer

A Publication of the Lunar Section of ALPO

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Back issues: http://www.alpo-astronomy.org/

January 2022

Online readers, click on images for hyperlinks

In This Issue

Wishing each of you a very Happy New Year, and hoping 2022 is a good year for you and your family. Thank you for reading this issue of *The Lunar Observer*. In this issue, 26 contributors in 10 countries submitted 114 lunar images, drawings and articles. Thank you so much! Rik Hill took us on a tour around Albategnius and Mare Crisium. Darryl Wilson continues a series on lunar color imaging, with much interesting information. Robert H. Hays, Jr. added a beautiful sketch and article about Picard and Mare Crisium. Alberto Anunziato provided articles about the crater Hall and Dorsa Heim. Alberto also contributed two extensive articles about this month's Focus-On topic, Mare Crisium. It is quite a task to coordinate all the observations that he gets, and to put together such interesting articles. David Teske looked at Mare Crisium from a collection of older lunar atlases. It turns out we are taking some very fine lunar images today! As always, Tony Cook provides another insightful article on Lunar Geologic Change as well as putting together the BAA Lunar Circular. I hope that you enjoy this issue.

Remember at the end of this issue are announcements for future Focus-On subjects.

Lunar Topographic Studies

Coordinator – David Teske - david.teske@alpo-astronomy.org
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Observations Received

Name	Location and Organization	Image/Article
Alberto Anunziato	Paraná, Argentina	Article and drawing *Dorsum Heim From My Backyard and From Lunar Orbit, A Pareidolia In Hall, articles Focus-On Mare Crisium, Mare Crisium a Report From Latin America*, images of Mare Crisium (3) and drawing of Eimmart.
Sergio Babino	Montevideo, Uruguay	Images of Mare Crisium (2).
Francisco Alsina Cardinalli	Oro Verde, Argentina	Images of Mare Crisium (3).
Jairo Chavez	Popayán, Colombia	Images of Mare Crisium (2), the waxing gibbous Moon and Full Moon.
Pablo Contreras	Concepción, Chile	Images of Mare Crisium (3).
Walter Ricardo Elias	AEA, Oro Verde, Entre Rios, Argentina	Images of Mare Crisium (6) and Proclus (6).
Desiré Godoy	Oro Verde, Argentina	Images of Mare Crisium (4).
Victoria Gomez	AEA, Oro Verde, Entre Rios, Argentina	Image of Proclus.
Facundo Gramer	AEA, Oro Verde, Entre Rios, Argentina	Images of Mare Crisium (2).
Robert H. Hays, Jr.	Worth, Illinois, USA	Article and drawing *Picard and Southwest Mare Crisium.*
Rik Hill	Loudon Observatory, Tucson, Arizona, USA	Article and image *Albategnius to Almanon, A Tale of Two Mare* and images of Mare Crisium (8).
Eduardo Horacek	Mar del Plata, Argentina	Images of Mare Crisium (4) and Lunar X.
Richard Martin	Canelones, Uruguay	Image of Mare Crisium.
Rafael Lara Muñoz	Guatemala, Guatemala	Images of Mare Crisium.
Rafael Benavides Palencia	Cordoba, Spain	Images of Vallis Alpes, Sinus Iridum and Copernicus.
Jesús Piñeiro	San Antonio de los Altos, Venezuela	Images of Mare Crisium (3).
Gabriel Re	AEA, Oro Verde, Entre Rios, Argentina	Image of Proclus.

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

Lunar Topographic Studies

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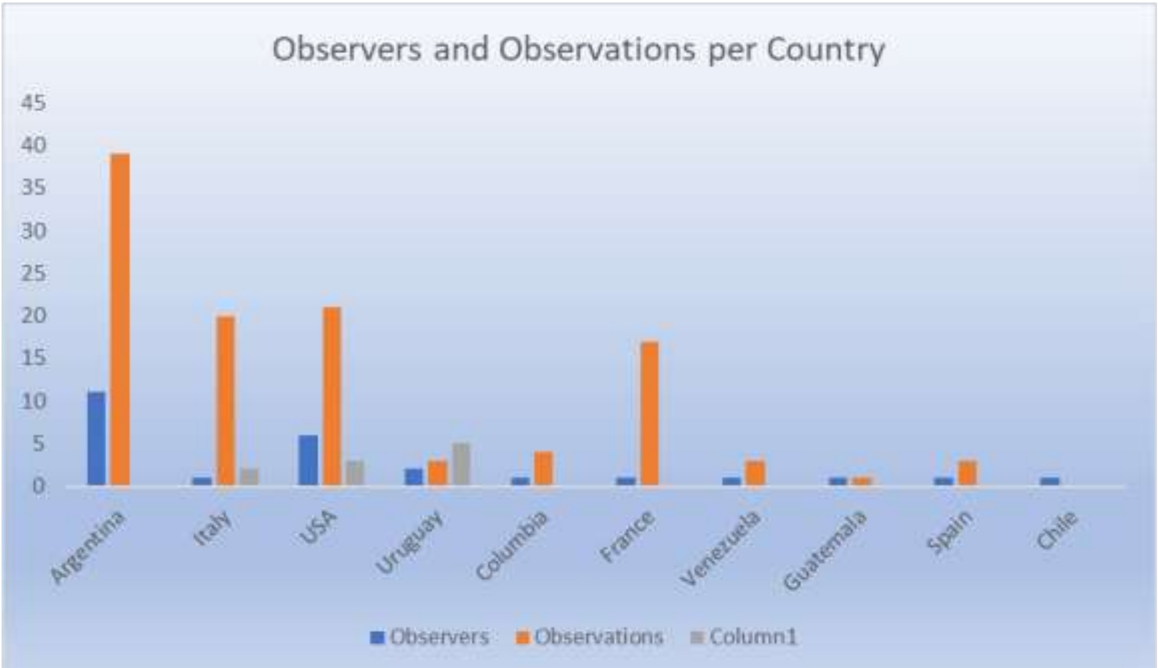
Observations Received

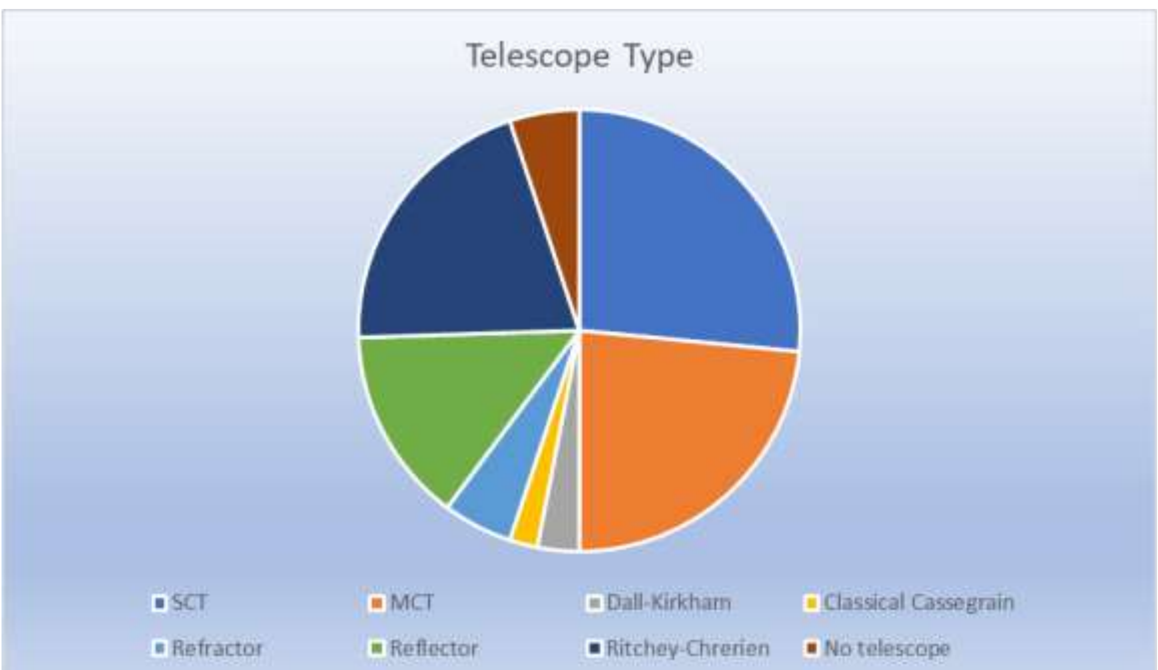
Name	Location and Organization	Image/Article
Leandro Sid	AEA, Oro Verde, Argentina	Images of the Moon and Venus conjunction (2).
Fernando Surá	San Nicolás de los Arroyos, Argentina	Images of Mare Crisium.
Michael Sweetman	SKY CREST OBSERVATORY, Tucson, Arizona, USA.	Images of Ptolemaeus and Rupes Recta.
David Teske	Louisville, Mississippi, USA	Images of Mare Crisium (6).
Randy Trank	Illinois, USA	Image of Mare Crisium.
Román García Verdier	Paraná, Argentina	Images of Mare Crisium (2).
Fabio Verza	\`SNdR, Milan, Italy	Images of Mare Crisium (15), Moon and Venus (2) and Full Moon (3)
Christian Viladrich	France	Images of the Alpine Valley, Ariadaeus (2), Clavius (2), Hyginus, Maginus, Plinius, Stöfler (2), Mare Crisium, Eudoxus (2), Aristoteles, Lacus Mortis, Tycho and Moretus.
Darryl Wilson	Marshall, Virginia, USA	Article: *A Sharpening Technique in HSV Colorspace for Lunar Surface Material Discrimination RGB->HSV; enhance S; replace V; HSV->RGB*

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

January 2022 *The Lunar Observer*
By the Numbers

This month there were 114 observations by 26 contributors in 10 countries.





Albategnius to Almanon

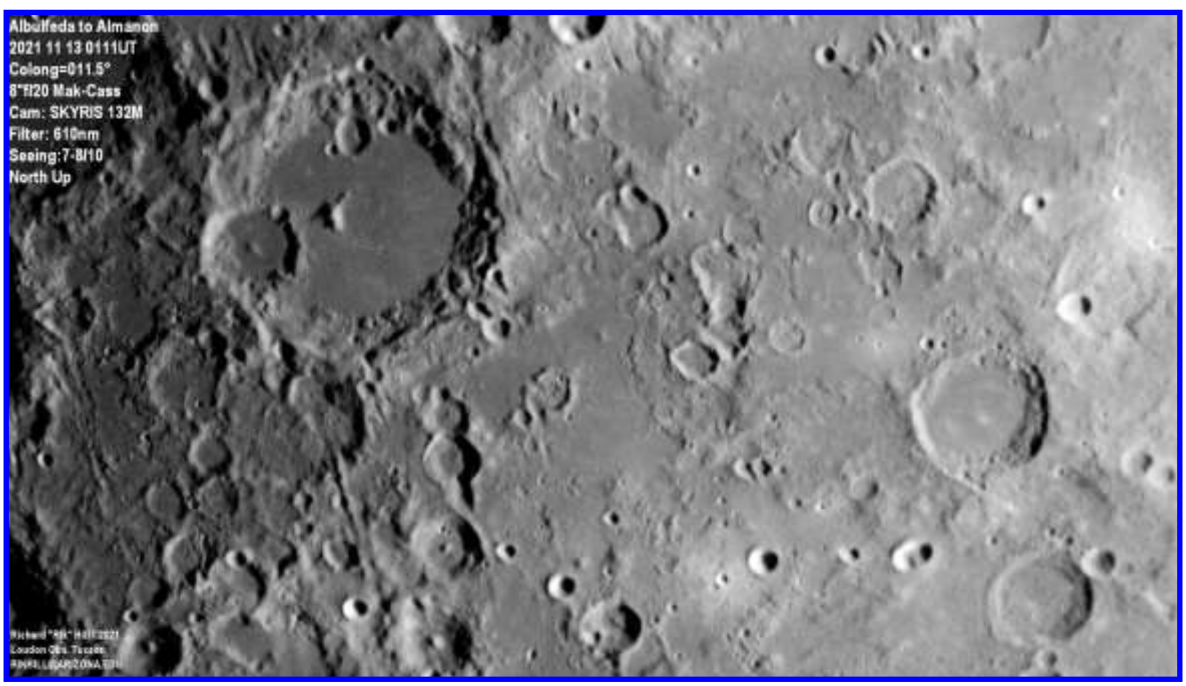
Rik Hill

The large crater in the upper left quadrant of this image is Albategnius (139 km dia.) with Klein (46 km) on its west wall (left). I love the structure of the southern interior wall of Albategnius. There are large diagonal scars all over this region from city sized rocks that were ejected during the Imbrium impact. South of Albategnius is an odd formation of several craters that look like they are crossed by one of these scars. Actually, the larger crater is Vogel (27 km) and there's a smaller crater to the north and an even smaller one on its north wall. Below Vogel is a trench created by two or three merged small craters. Below Vogel is the crater Argelander (36 km) and below that on the edge of this image is Airy (37 km) with its heavily eroded walls. On the opposite side of this image is the large flat floored crater Abulfeda (65 km) and below it the smaller Almanon (51 km). Between them notice the string of craters Catena Abulfeda its full length some 216 km long.

East of Vogel (right) is a curious feature sitting it the small flat region. This is Burnham listed as a 26 km crater but a crater unlike any other in this field. The little crater on its west wall is Burnham F (9 km). Right next to this little crater is a breach in the wall of Burnham and there's another breach in the north wall. This latter breach appears on LROC QuickMap imagery, to be a heavily eroded impact. The floor of Burnham is a covered with mounds and pits, no central peak or hint of one. It's a very chaotic small region. On the opposite side of Burnham from Burnham F is another small crater Burnham K (3 km).

East (right) of Burnham is a strange mash of craters starting with Abulfeda D (20 km) with a pinched wall on the west side. Above it 5 or 6 craters are overlapped ending with Ritchey N (17 km) at the top of the row. Ritchey (26 km) itself is to the northwest of Ritchey N, and is overlain by several smaller craters to the north of it.

This region repays some study on a good steady night and some magnification.

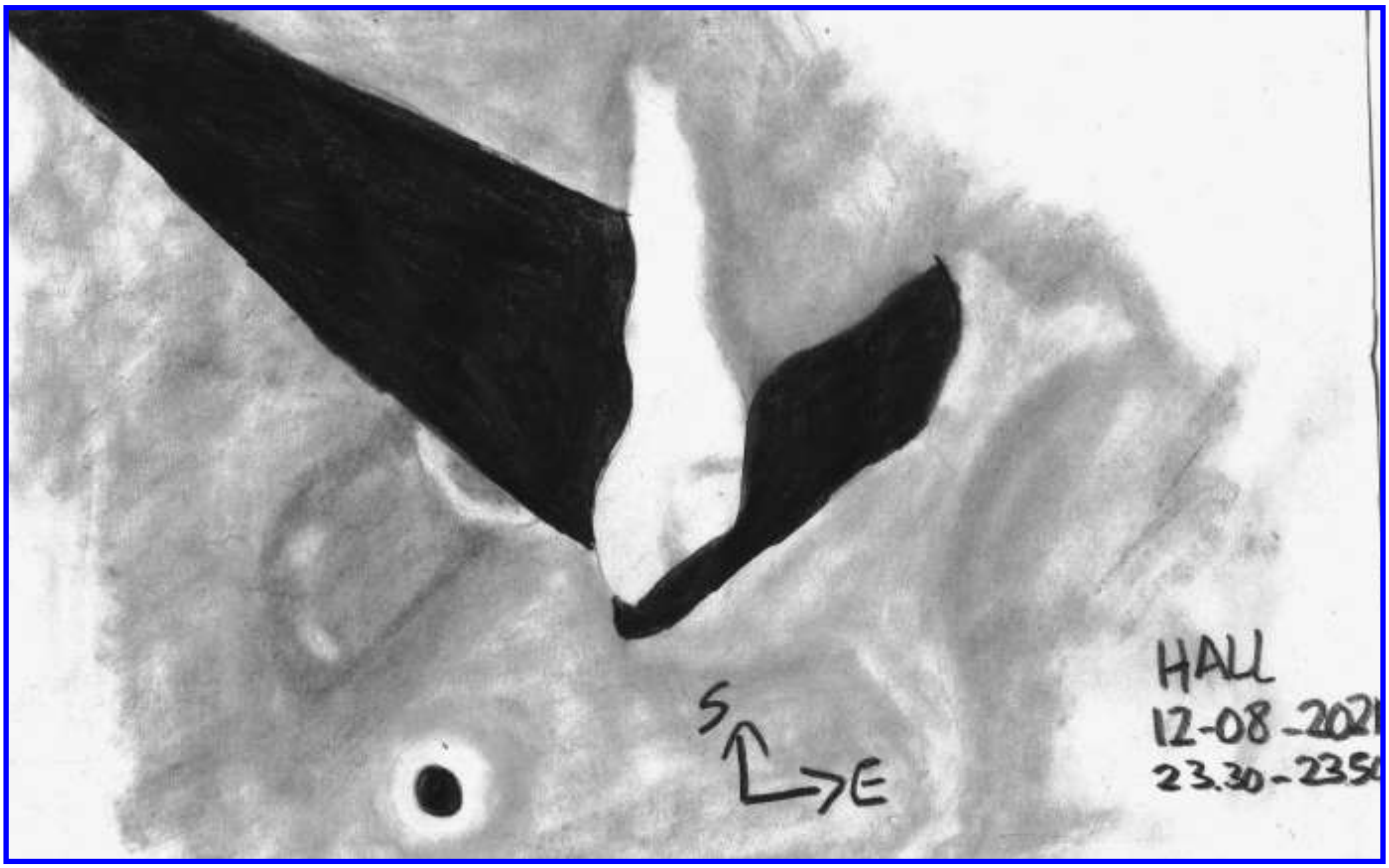


Abulfeda to Almanon, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2021 November 13 01:11 UT, colongitude 11.5°. 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 132M camera. Seeing 7-8/10.*

A Pareidolia in Hall

Alberto Anunziato

We are not going to make an analysis of an ancient pre-Imbrian crater, Hall, 40 kilometers in diameter, a wrecked formation with very steep walls. We are going to comment on a subjective, impressionistic experience of observing Hall crater at colongitude 327.2º, with the terminator passing very close. Looking at the Moon with a telescope reveals unique wonders in each observation. What was seen was a very luminous area of irregular shape, in the shape of a candle, or like the tower of a sand castle, as children do accumulating wet sand on the beach. At first this area seemed unrelated to the surrounding topography, it looked like a kind of tower in the middle of nowhere, an independent moon feature. This illusion occurred because this bright area was delimited by very dark shadows. Looking at the Virtual Moon Atlas, the mystery was solved: it is the west wall of Hall, surely very high if we relate brightness to height. The brightness of the north and east walls is much weaker, which helps make the west wall look like a separate feature. Who knows if we will see that wonder again, but other lunar wonders await us.



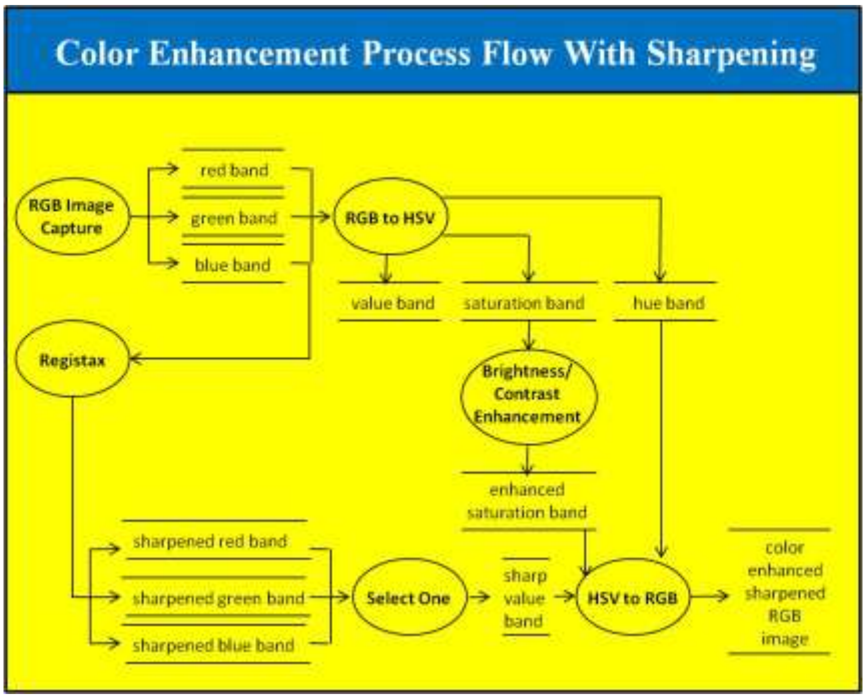
Hall, *Alberto Anunziato, Paraná, Argentina. 2021 December 08 23:30-23:00 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

A Sharpening Technique in HSV Colorspace for Lunar Surface Material Discrimination
RGB->HSV; enhance S; replace V; HSV->RGB
Darryl Wilson

This is the second of a series of articles that will demonstrate the value of imaging the moon in color. The first article (Dec. 2021) introduced one color enhancement technique - the RGB to HSV transformation. This article shows how an extension to that technique can be used to sharpen the color image in HSV space.

Howard Eskildsen recently published an excellent enhanced color image of the moon in TLO (Oct. 2021). It is interesting to compare his image with the ones presented in this article. In all cases, the color-enhanced images show details on the lunar surface that are invisible to the human eye. A key point is that two different astronomers, using two different imaging devices, with telescopes of three different designs and apertures, on three different dates, recorded essentially the same features on the lunar surface. This color enhancement technique can produce repeatable and valid results.

Figure 1 shows the process flow that was used for all but one of the images presented here. The image on the left side of Figure 2 is the exception. It is an unsharpened color image of the moon that was generated using the process flow diagrammed in last month's issue of TLO. The right side of Figure 2 shows the HSV-based Registax sharpened version. Even though spatial detail is limited because these two images were taken with a 3" refractor, the sharpening effect is obvious if one zooms in to see small details. We also see that good quality color enhancement can be done even with small apertures.



Above Figure 1

Left, Figure 2.

The Value (V) band computed during the RGB-to-HSV transformation is a grayscale image. A different grayscale image may be substituted by replacing the V band with the other band prior to backtransforming. For this article, the modification to the process flow involved processing the original RGB image with Registax and selecting one of the three sharpened bands (red in this case) as the replacement for the V band.

This is a flexible aspect to the HSV-based color enhancement process. We are free to sharpen (using Registax or another method), adjust brightness and contrast, perform noise reduction, or apply more complex operations on the replacement image before inserting it in place of the original V band. In future articles we will see examples of other useful substitutions.

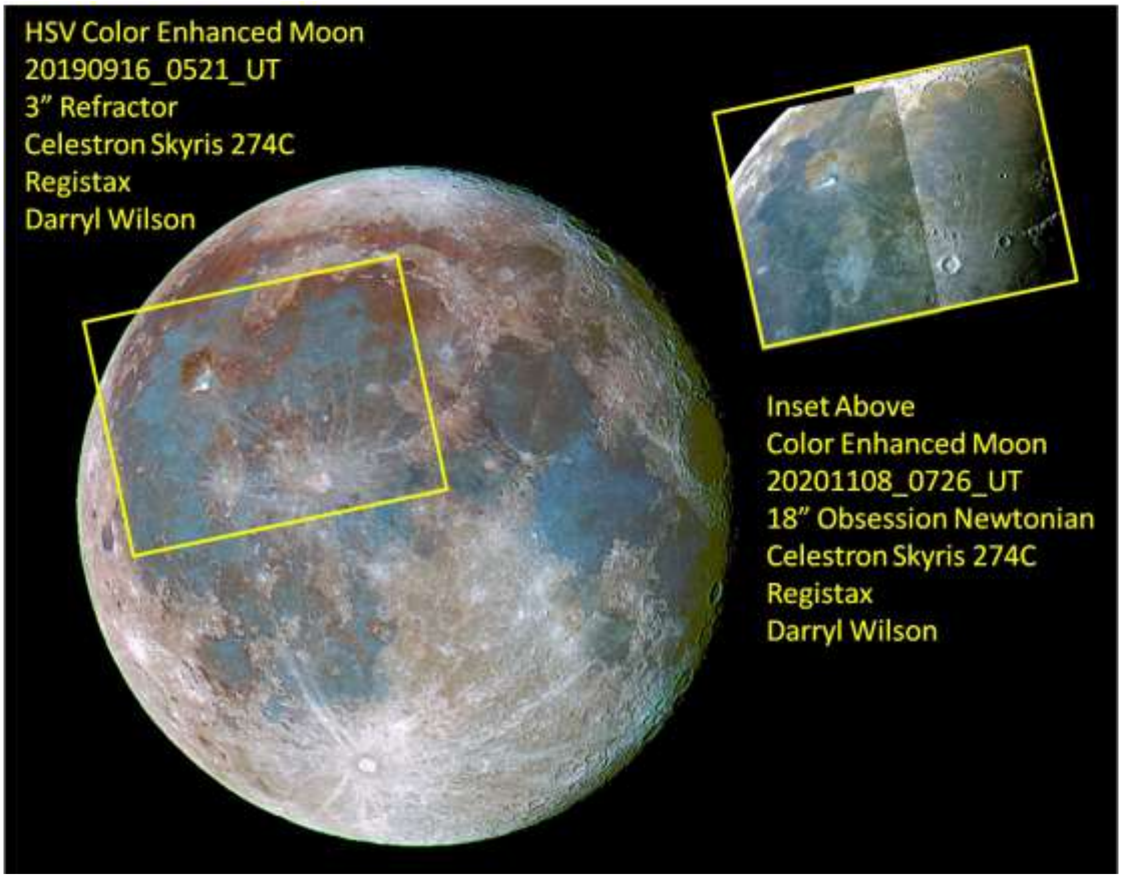


Figure 3 shows a somewhat enlarged version of the result with a superimposed rectangular footprint representing the area of coverage of higher -resolution imagery. The inset image in the upper right is a mosaic that was taken with an 18" scope. It is interesting to compare the images taken with different apertures when they are presented at the same scale. Although the colors do not match exactly, the spatial patterns of color delineation are essentially identical.

Left Figure 3

Figures 4 and 5 were processed according to the process flow diagrammed in Figure 1. They show a wealth of detail that is not visible in grayscale images.

Figure 4 shows the northern region of Oceanus Procellarum. Last month we noted that the blue regions in the mare are relatively rich in titanium (Ti) and the brownish areas are relatively poor in Ti content. The Aristarchus plateau is clearly a Ti-poor area in an ocean of Ti-rich basalts. Moving from the plateau towards von Braun, we first cross a Ti-rich area, then we reach the edge of a Ti-poor brownish zone. What is visually striking is the many shades of blue and brown that we can see, and the fact that they often change sharply over small spatial scales. It is as if we can suddenly see shorelines that were formed when molten magma flowed on the surface of the moon.

A semicircle of Ti-poor material can be seen roughly 100 miles from Kepler on its western side. In grayscale images, it is faintly visible as an area with slightly higher albedo. Color imagery reveals that its minerology differs from the surrounding surface material.

Figure 4, Color Enhanced Moon, *Darryl Wilson, Marshall, Virginia, USA. 2020 November 08 07:26 UT. 18 inch Obsession Newtonian reflector telescope, Celestron SKYRIS 274C camera, HSV sharpening with Registax.*

Mare Imbrium is showcased in Figure 5. The northeastern region, adjacent to Plato, is uniformly chocolate-brown (not cheese-green). As one proceeds in a SW direction from Plato, after traveling roughly 150 miles across Ti-poor mare surface, a sharp transition occurs. Within one or two miles, the Ti content of the surface changes abruptly from very low to very high, as indicated by the color change from brown to blue. The Imbrium basin can be characterized as having a Ti-rich center with Ti-poor shores.

It is hard to ignore the presence of Copernicus in the lower half of the scene. Both the interior and the surrounding area within 100 miles of the center are primarily shades of blue. The blue has low saturation where rays are present, and somewhat higher saturation levels elsewhere. A barely visible pie-piece shaped area in the upper interior of the crater (from about 11 O'clock to 1 O'clock) is slightly brownish, but only barely detectable. The slightly brownish tinge seems to possibly extend beyond the rim out to the exterior of the northern wall. Next month we will zoom in on Copernicus to see if this weak feature is real or just an artifact of processing.

This is a good time to discuss mitigation of color noise. Everyone who processes digital images has encountered processing artifacts. Ringing around bright pixels in oversharpened images is perhaps the first problem we encountered, but not the last. When we enhance color saturation, we also enhance the saturation of unwanted color features in our images. Often unnoticeable, these features can be quite eye-catching after a saturation stretch. They are mainly caused by three phenomena, 1) atmospheric refraction, 2) chromatic aberration, and 3) bad seeing.

Atmospheric refraction can be a serious problem unless the moon is far above the horizon. How far? It can be quantified based on the lunar elevation angle, the IFOV of the detectors, the focal length of the telescope, and the spectral transmission curve of the filters, but quantification is beyond the scope of this article. A simple, practical remedy is to coregister the red, green, and blue bands of the raw RGB imagery before transforming to HSV colorspace. This approach was used here.

Chromatic aberration has not proved to be a significant problem since this author used a reflector and an apochromatic refractor for all images presented so far. An achromatic refractor is expected to produce unsatisfactory images for saturation enhancement. In fact, this technique could be used to highlight, and compare, color correction deficiencies in refractor telescopes. One person's noise is another person's signal.

Figure 5, Color Enhanced Moon, *Darryl Wilson, Marshall, Virginia, USA. 2020 November 08 07:28 UT. 18 inch Obsession Newtonian reflector telescope, Celestron SKYRIS 274C camera, HSV sharpening with Registax.*

Bad seeing causes intermittent spurious color in bright stars as well as bright mountain peaks and crater walls on the lunar surface. Due to the random nature of this effect, it is averaged into insignificance during the image stacking process. If saturation enhancement is applied to a single RGB image that has seeing-induced spurious color, the result may be undesirable. Spurious color will be more prominent.

In summary, we introduced a novel image sharpening technique that operates in HSV space. We used it to sharpen a low-resolution image taken with a 3" refractor and high-resolution images taken with an 18" reflector. Clearly defined spatial color patterns indicative of Ti content on the lunar surface were noted in Oceanus Procellarum and Mare Imbrium. We noted that the transition from the most Ti-poor to the most Ti-rich surface material often occurs sharply, over a spatial scale of at most one to two miles. The interior of Copernicus was suspected to have a Ti-poor area but the color contrast was too weak to rule out rule out an image processing artifact as the cause. Finally, we briefly discussed three potential causes of color noise and mitigation measures.

The next few articles will focus on applying the process flow in Figure 2 as we image other regions of the moon and zoom in to selected features. After that, we will explore more sophisticated processing techniques than the HSV transform and see how they may be applied to RGB color images. We will see that surface details that are invisible in both grayscale and saturation-enhanced color images (as well as to the eye) can be revealed.

References:

Eskildsen, Howard, "Color Saturation Enhanced Waning Gibbous Moon", October, 2021, "The Lunar Observer", 14-15.

Wilson, Darryl G., "A Basic Color Enhancement Technique for Lunar Surface Material Discrimination", December, 2021, "The Lunar Observer", 5-7.

Dorsum Heim
From My Backyard and From Lunar Orbit
Alberto Anunziato

It is already a habit to look for the wrinkle ridges that are right in the terminator and to try to document them as well as possible. On the night of November 14, the most conspicuous dorsum was Dorsum Heim, recognizable because it runs on both sides of the C (Caroline) Herschel crater (13 km in diameter), in the Mare Imbrium. Illuminated from the east (33.8 ° colongitude), the three overlapping wrinkle ridge segments east of C Herschel cast extensive dark shadows (except in the vicinity of the crater). In each segment, from east to west, there is a bright part. In the first segment we see a small area of faint glow (which I thought might be a crater), in the second segment we see a very bright stripe and in the third segment a bright stripe and further west a smaller bright one.

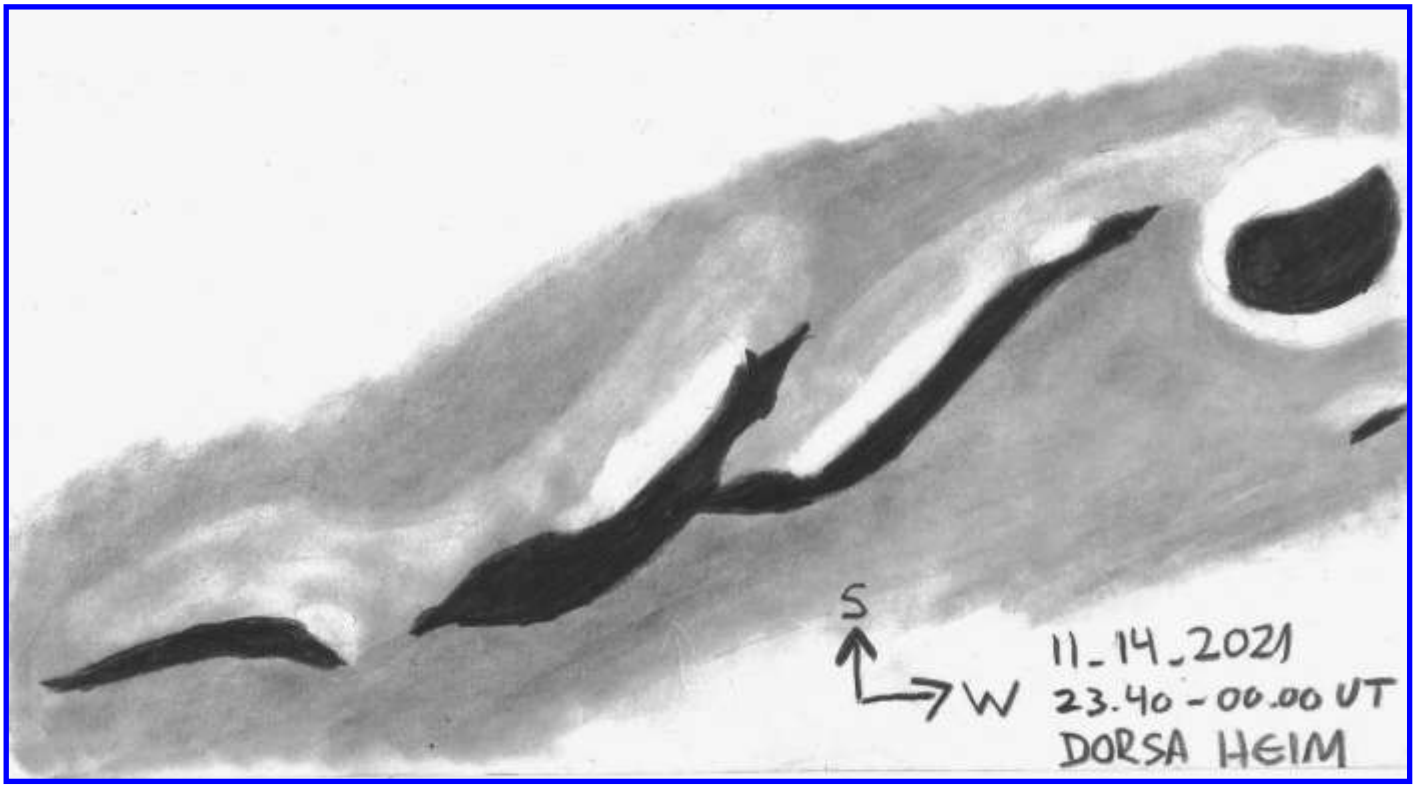


Image 1, Dorsa Heim, *Alberto Anunziato, Paraná, Argentina. 2021 November 14 23:40-00:00 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

Looking for some information on the internet I found this splendid image (IMAGE 2) of the Dorsum Heim taken from lunar orbit by the Apollo 17 mission (AS17-155-23712). The degree of detail is amazing, you can clearly see the two components of a wrinkle ridge: the gently sloping and broad arch and the sharper crest (which are the ones that cast shadow in IMAGE 2). The lighting conditions are similar, oblique light and close to the terminator, but IMAGE 1 was taken with a crescent moon while the changed shadows in IMAGE 2 show that it was taken with a waning moon. I rotated IMAGE 2 to match the drawing I made in my observation notebook and then reproduced on IMAGE 1.

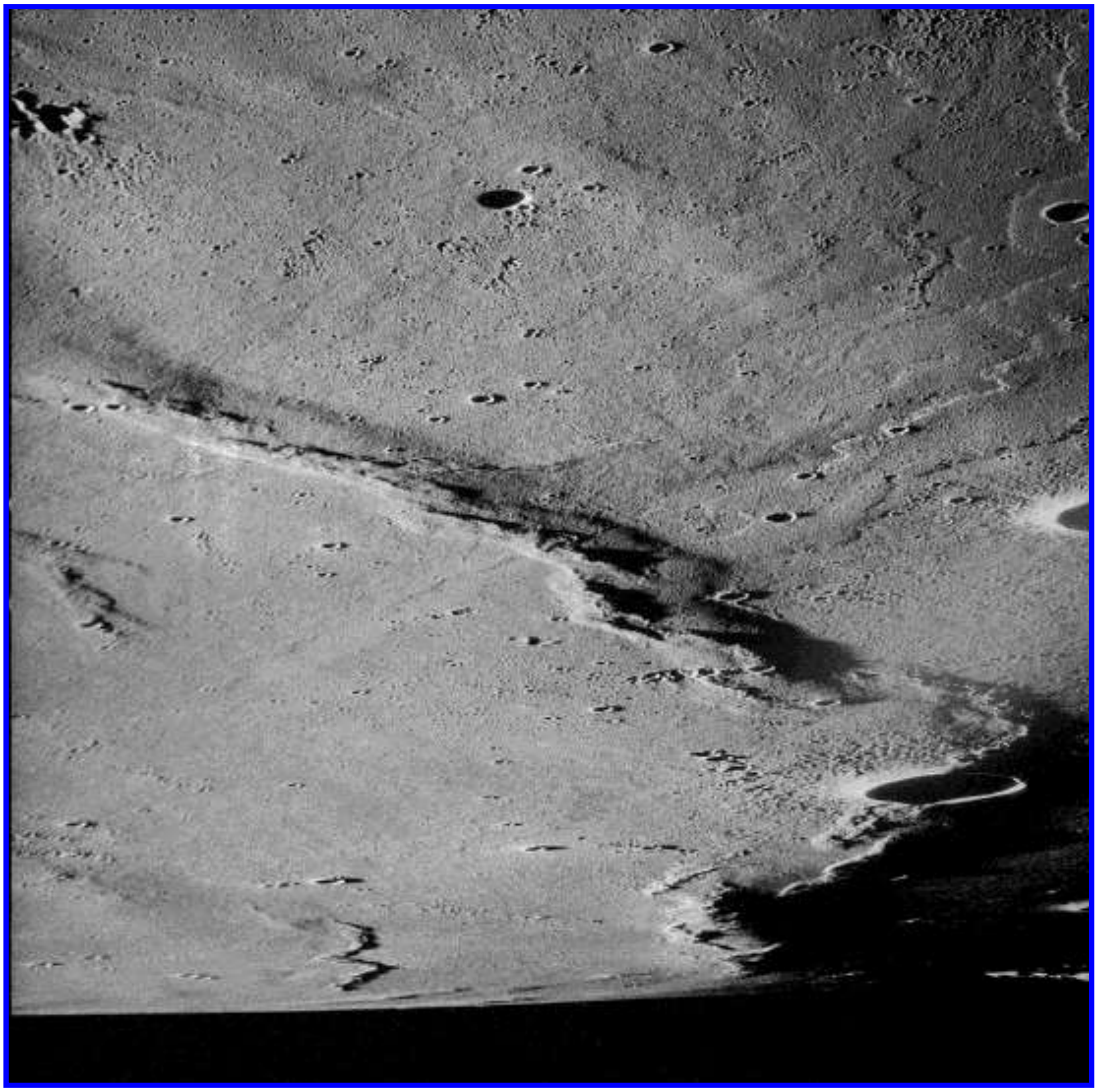


***Image 2, Dorsum Heim**, AS17-155-23712, image from Apollo 17.*

It is extremely interesting to note how the different segments of the ridge above the arch shine in IMAGE 1 and how it corresponds to the highest areas of the Apollo 17 image. In IMAGE 3 I marked the 3 crests that appear shining in my observation with arrows of different colors and that they would correspond to the highest areas of the Apollo 17 image, each identified with the same color in the two images. For the zone of weak brightness in the first segment from the east I find no correspondence in the Apollo 17 image.

It is really encouraging to think that we can observe from the backyard of our house, with a telescope of only 4 inches, what the astronauts in lunar orbit saw. Additionally, we will continue to record the bright areas on the wrinkle ridges near the terminator, knowing that they do indeed correspond to the higher areas.

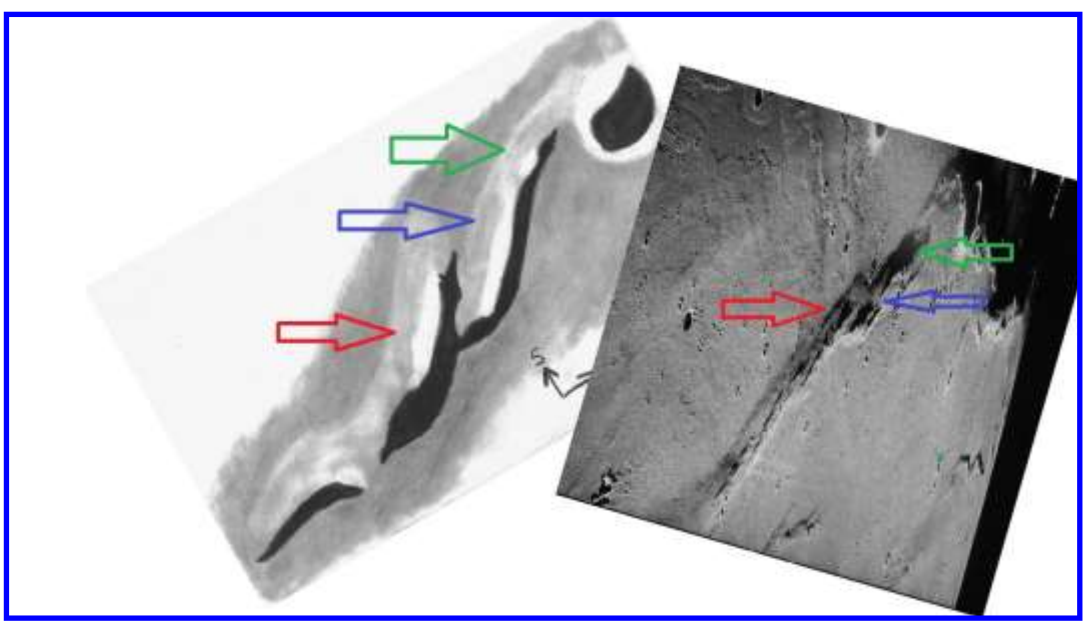


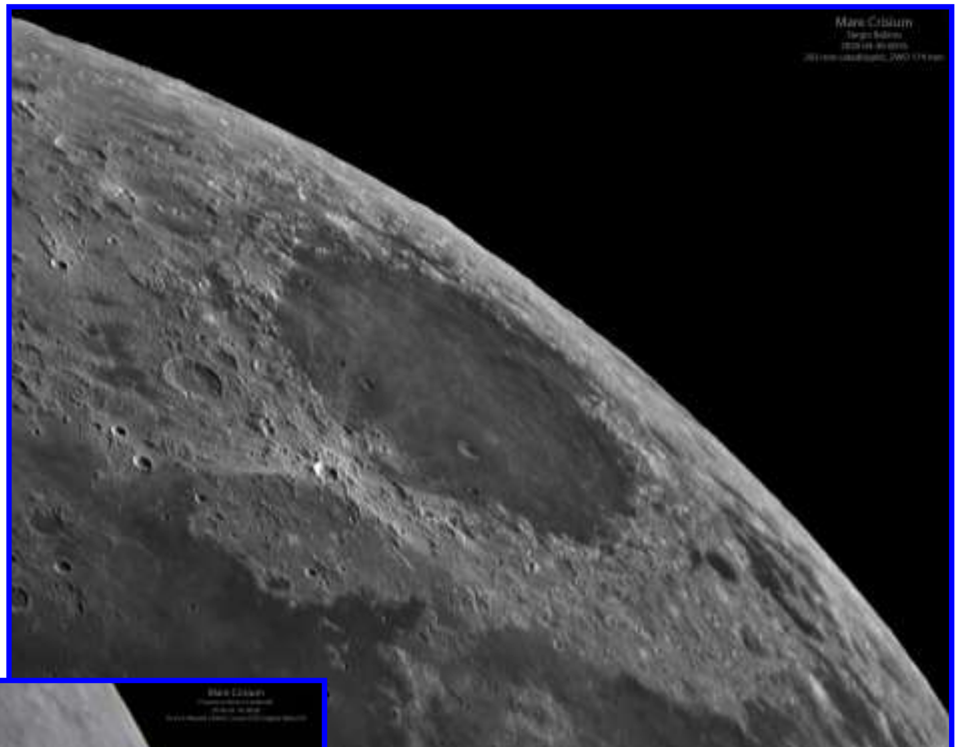
***Image 3, Dorsum Heim**, Alberto Anunziato, Paraná, Argentina. 2021 November 14 23:40-00:00 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x and AS17-155-23712, image from Apollo 17.*

Focus-On Mare Crisium

Alberto Anunziato

DESCRIPTION

In this "Focus On" we are going on a tour through a very diverse land (even if it is called the sea). Mare Crisium is not very extensive and is almost perfectly delimited, so it is possible to analyze it quite precisely. We will turn to a series of lunar books, which we highly recommend, to recognize the characteristics of Mare Crisium. We thank the authors for the wonders that we are going to visit.



Right, Mare Crisium, *Sergio Babino, Montevideo, Uruguay. 2020 April 30 00:16 UT. 203 mm catadrioptic telescope, ZWO ASI174mm camera.*

Mare Crisium is a pre-Imbrian basin (3.9 billion years old) with a very flat floor of Upper Imbrian material. In the center of the flat and thick lava material of the mare a mass concentration (or mascon) was identified by the Lunar Orbiter 5 mission.

Below, Mare Crisium, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2016 January 16 00:28 UT. 10 inch Meade LX200 Schmidt-Cassegrain telescope, Canon EOS Digital Rebel XS camera.*

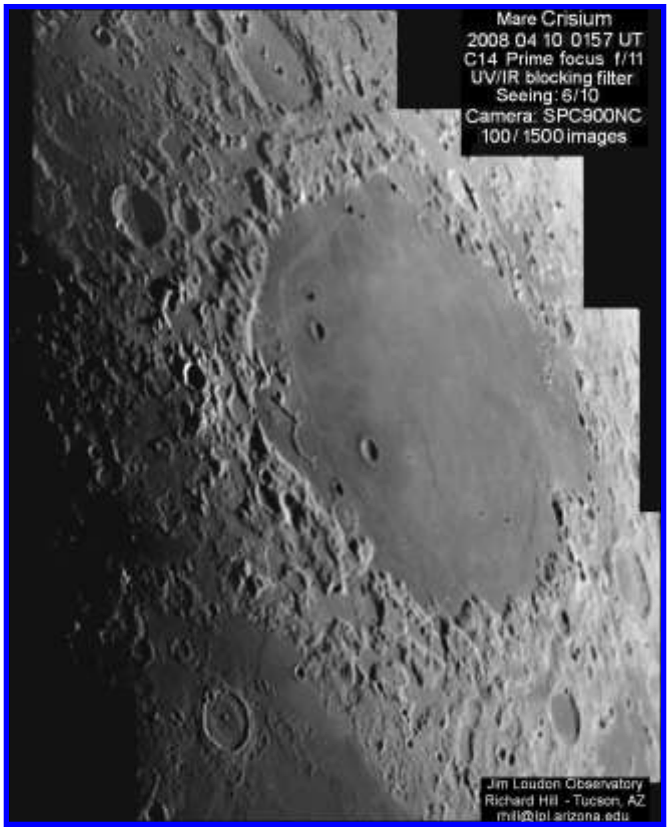
Like a crater, Crisium is the only mare on the near side that does not communicate with the other maria. "Crisium is probably between the Serenitatis and Nectaris basins in age, closer to Serenitatis. Mare Crisium has properties in common with both Maria Serenitatis and Nectaris. It has a mascon, as do both of these maria. The basalt section is about as thick as that of Serenitatis and thicker than that of Nectaris (Wilhelms, page 241).

Mare Crisium, *Jairo Chavez, Popayán, Colombia. 2021 October 10 23:50 UT. 311 mm truss Dobsonian reflector telescope, MOTO E5 PLAY camera. North is down, west is right.*

Peter Grego's description of Mare Crisium (page 143) is a good introduction to our feature: “Mare Crisium has an oval shape measuring 570 x 450 km, its longest axis oriented east – west. From our terrestrial vantage point, foreshortening causes its east – west axis to be squashed. Its total surface area measures 176,000 sq km. (…) With its well-defined oval outline, Mare Crisium looks more like a large, flooded crater (which is exactly what it is) than any other mare on the Moon’s nearside”.

Mare Crisium, *Jesús Piñeiro, San Antonio de los Altos, Venezuela. 2021 November 08 22:20 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, Astronomik L2 UV/IR cut filter, ZWO ASI462 MC camera.*

We chose Mare Crisium because it is a Moon in miniature, a kind of theme park in which all the characteristics of the lunar surface can be found in a small space (except arcuate grabens). The idea comes from Charles Wood: "This mare boasts both giant and tiny oblique impact features, nearly hidden basins, a completely obscured crater that may have formed yesterday (geologically speaking) and other surprises that await your investigation" (page 91).



Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2008 April 10 01:57 UT. Celestron 14 inch Schmidt-Cassegrain telescope, f/11, UV/IR blocking filter, SPC900NC camera. Seeing 6/10.*

Mare Crisium, *David Teske, Louisville, Mississippi, USA. 2020 March 06 02:32 UT, colongitude 44.8°. 3.5 inch Questar Maksutov-Cassegrain telescope, IR block filter, ZWO ASI 120 mm/s camera. Seeing 8/10.*

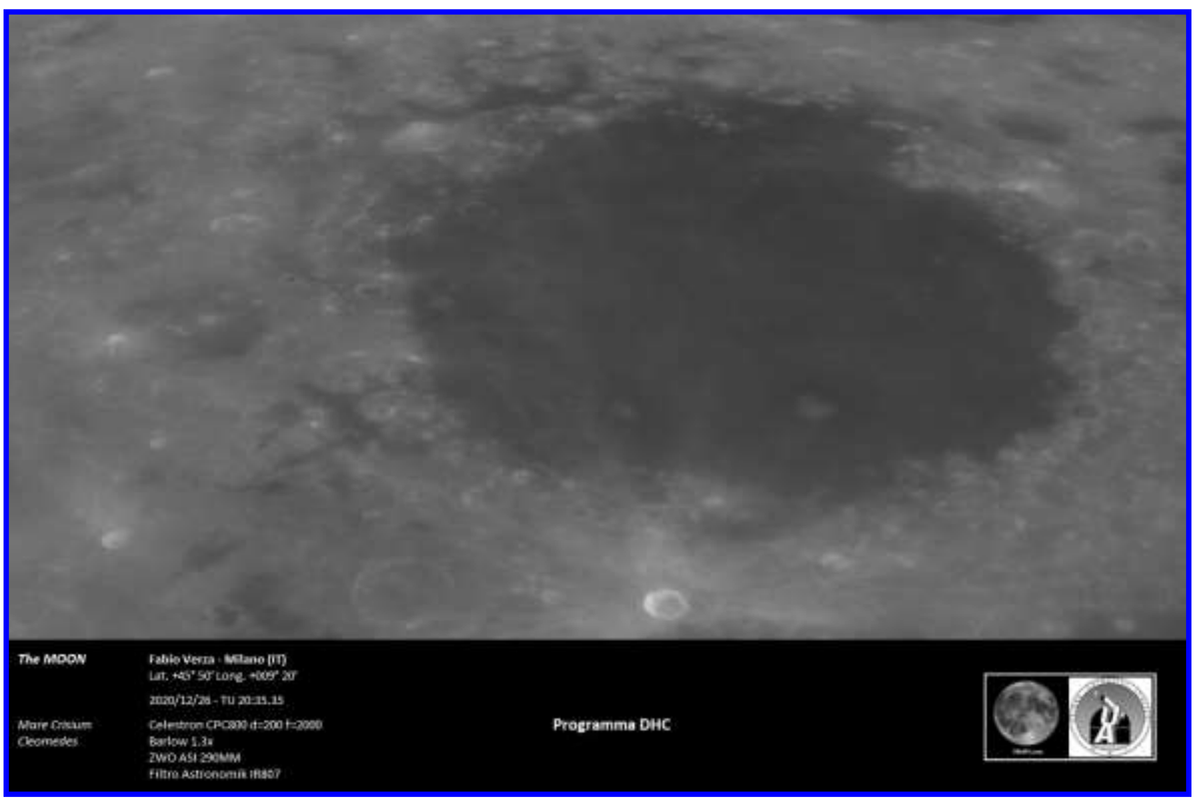
Mare Crisium, *David Teske, Louisville, Mississippi, USA. 2021 January 19 00:59 UT, colongitude 333.8°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI 120 mm/s camera. Seeing 6-7/10.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2017 June 11 23:06 UT. Celestron 6 inch Schmidt-Cassegrain telescope, IR pass filter, ZWO ASI120mm/s camera.*

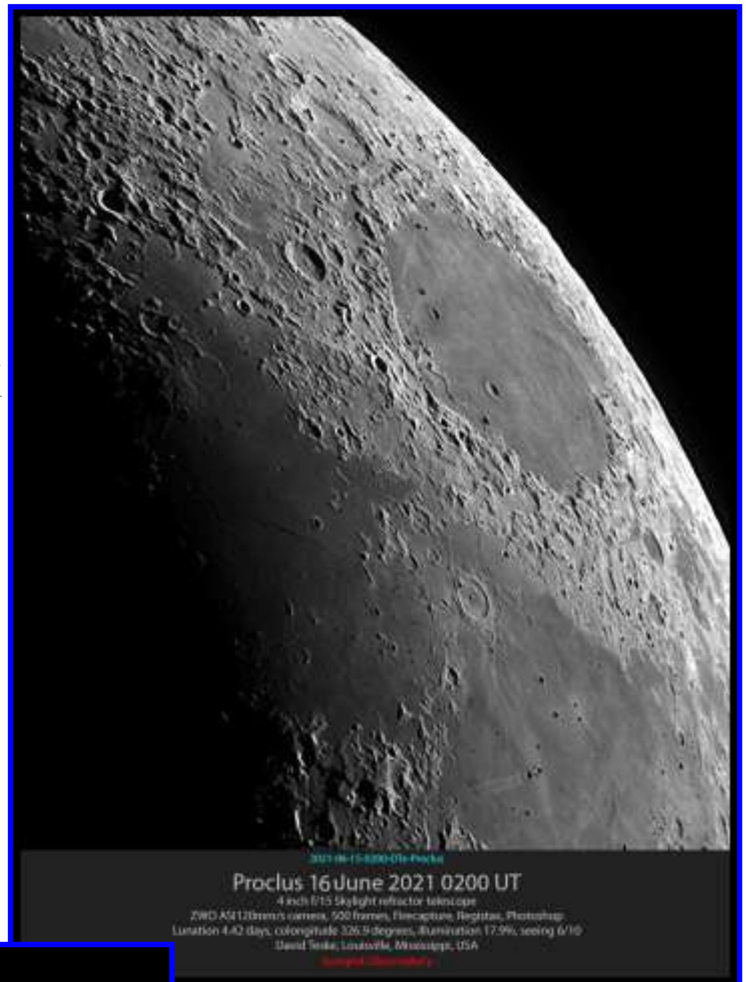
Mare Crisium, *Pablo Contreras, Concepción, Chile. 2021 November 15 23:03 UT. 152 mm Ritchey Chrétien telescope, ZWO ASI 183 MC camera.*

Mare Crisium is a beautiful show, with any kind of illumination: "Viewers of the Moon around 2 days after new will be struck by the feature's appearance: bisected by the morning terminator, it makes an imposing dent in the Young lunar sickle, visible without optical aid to those with sharp eyes. When Mare Crisium is fully exposed to the morning sunshine a day later, it makes a grand spectacle through any instrument." (Grego, page 143)

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2020 December 26 20:35 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, Astronomik IR807 filter, ZWO ASI290MC/s camera.*



Mare Crisium, *David Teske, Louisville, Mississippi, USA. 2021 June 16 02:00 UT, colongitude 326.9°. 4 inch f/15 refractor telescope, IR block filter, ZWO ASI 120 mm/s camera. Seeing 6/10.*



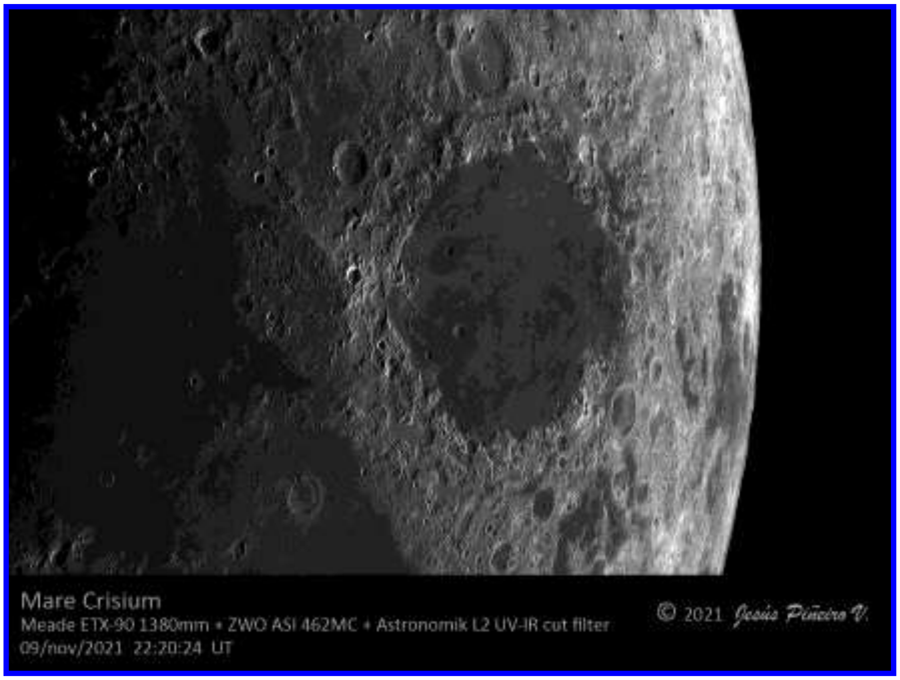
Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2020 June 26 20:11 UT. Celestron 4 inch Nexstar SE Maksutov-Cassegrain telescope, Astronomik IR block filter, ZWO ASI290MC/s camera.*

MOUNTAIN EDGE

The edge of Mare Crisium is very interesting and varied, its details are very difficult to observe visually but the photographic images show its complex structure. According to Peter Grego (pages 143/144): "Mare Crisium has imposing lofty mountain borders in the west, whose clean-cut scarp faces shine brilliantly in the morning. As the western mountain border casts broad shadows onto the mare in the early evening, a couple of days after full Moon, the eastern reaches of the sea begin to darken with the encroachment of the terminator, while the mountains of its eastern border shine in the last rays of the setting Sun. A considerable breach exists in the eastern mountain border, where the mare lava has flowed into outlying craters and valleys, notably Mare Anguis (…) A large mountainous headland, Promontorium Agarum, projects into Mare Crisium from its southeastern shore".

Right, Mare Crisium, *Eduardo Horacek, Mar del Plata, Argentina. 2020 October 03 03:31 UT. 150 mm Maksutov-Cassegrain telescope, Canon EOS Rebel T5i camera. North down, west right.*

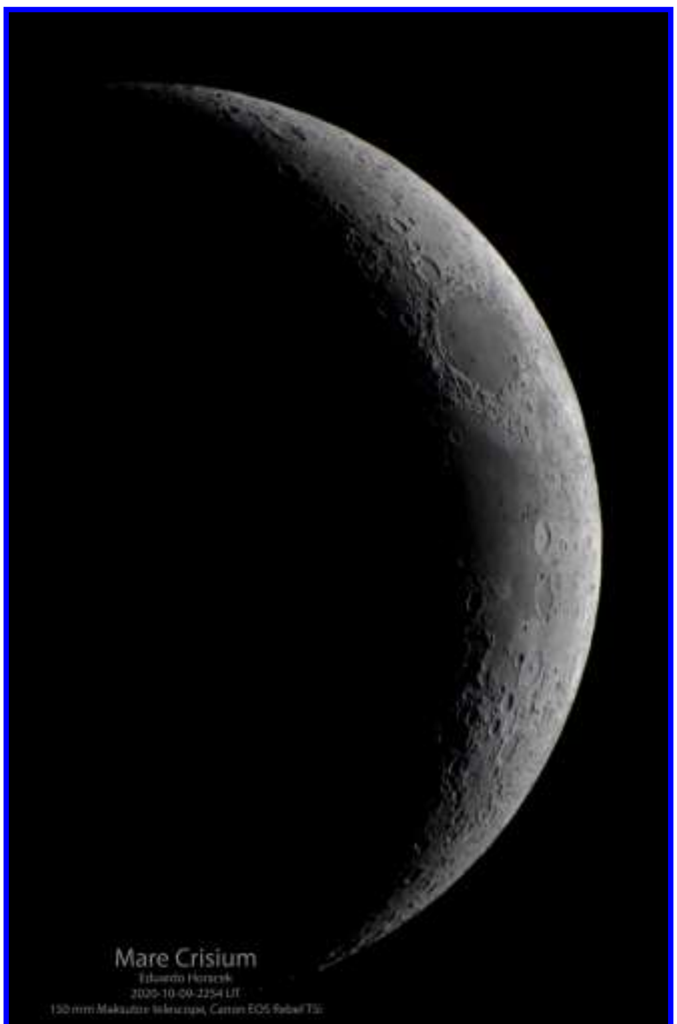
Mare Crisium, Román García Verdier, Paraná, Argentina. 2019 September 15 03:44 UT. 180 mm Newtonian reflector telescope, QHY5-II camera.



***Mare Crisium,** Jesús Piñeiro, San Antonio de los Altos, Venezuela. 2021 November 09 22:20 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, Astronomik L2 UV/IR cut filter, ZWO ASI462 MC camera.*

***Mare Crisium,** Rafael Lara Muñoz, Guatemala, Guatemala. 2021 October 09 00:35 UT. 114 mm Newtonian reflector telescope, Samsung Note 20 cell phone camera.*

***Mare Crisium,** Desiré Godoy, Oro Verde, Argentina. 2019 November 08 01:32 UT. 200 mm Newtonian reflector telescope, QHY5-LII-M camera.*



***Mare Crisium,** Eduardo Horacek, Mar del Plata, Argentina. 2020 October 09 22:54 UT. 150 mm Maksutov-Cassegrain telescope, Canon EOS Rebel T5i camera.*

Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2018 April 19 02:09 UT, colongitude 311.8º. 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 445M camera. Seeing 7/10.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2020 September 04 22:48 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, Astronomik IR807 filter, ZWO ASI290MC/s camera.*

With data from the Apollo 15 and Apollo 17 missions, which flew over the southern area of Mare Crisium, a topographic map was made showing that the edges of the sea rise between 2 and 5 kilometers above its surface. The highest point is Promontorium Agarum "a 50-km-wide block jutting into and towering 5.5 km above the southeastern part of the mare. An arm of the mare circles behind the cape like a vast fiord. In fact, if you look closely, you'll see a number of elongated fjord-like troughs behind the massifs on most sides of Crisium. Beyond these troughs the elevation of the surface is generally lower than the massifs, which defines a blocky ring 500 to 600 km wide around the circumference of the mare" (Wood, page 91).

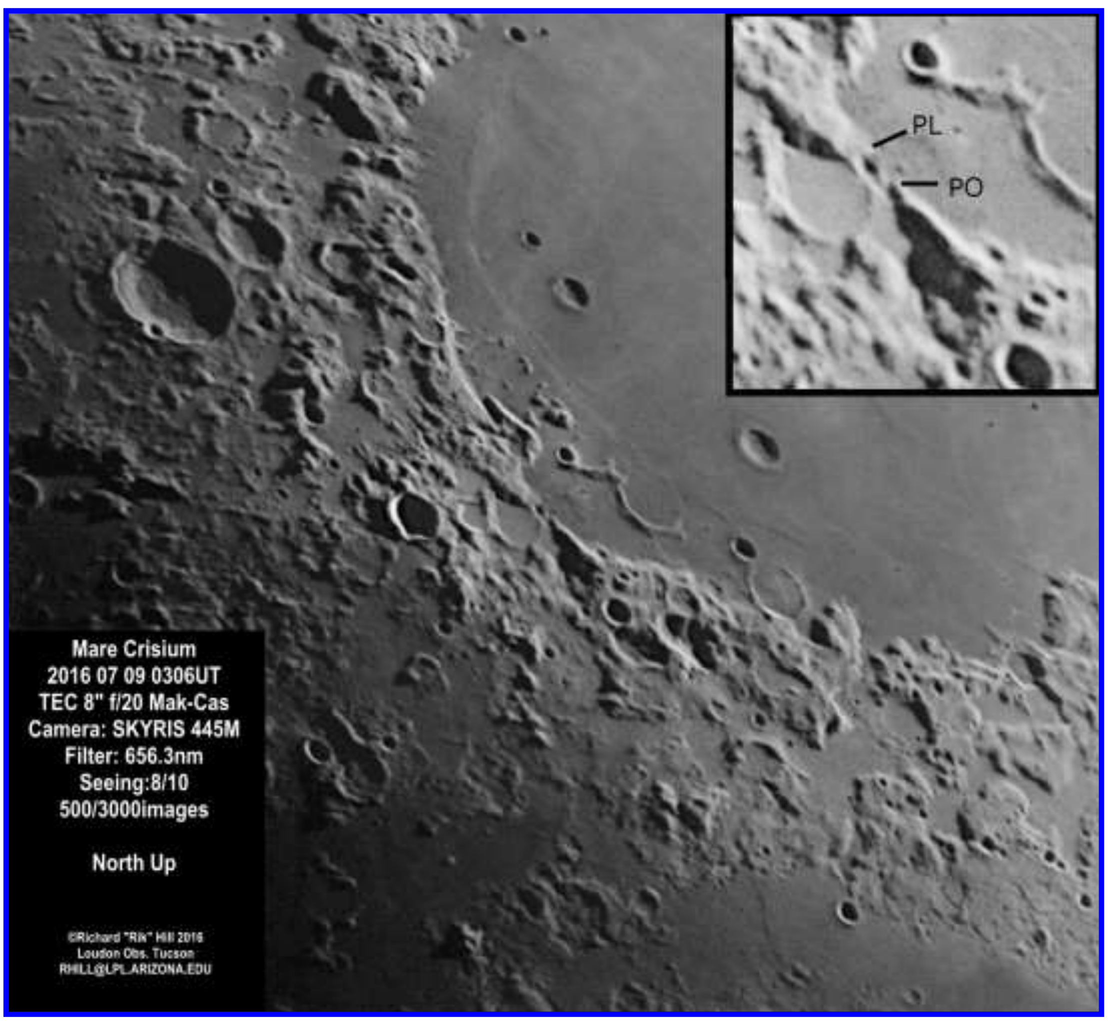
Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2017 April 14 03:41 UT. Celestron 6 inch Schmidt-Cassegrain telescope, Astronomik IR807 filter, ZWO ASI220mm/s camera.*

Among the curiosities of the fjord-like shore we see two very bright small craters on the south coast, especially the one located further west.

Near the west coast of Mare Crisium rise a series of low elevations, probably remnants of the topography flooded by the layers of lava that formed it.

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2018 June 17 19:15 UT. Celestron 8 inch CPC 800Schmidt-Cassegrain telescope, 1.3 x barlow, IR pass+W23 filter, ZWO ASI290MC/s camera.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2020 September 03 21:27 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, Astronomik IR807 filter, ZWO ASI290MC/s camera.*

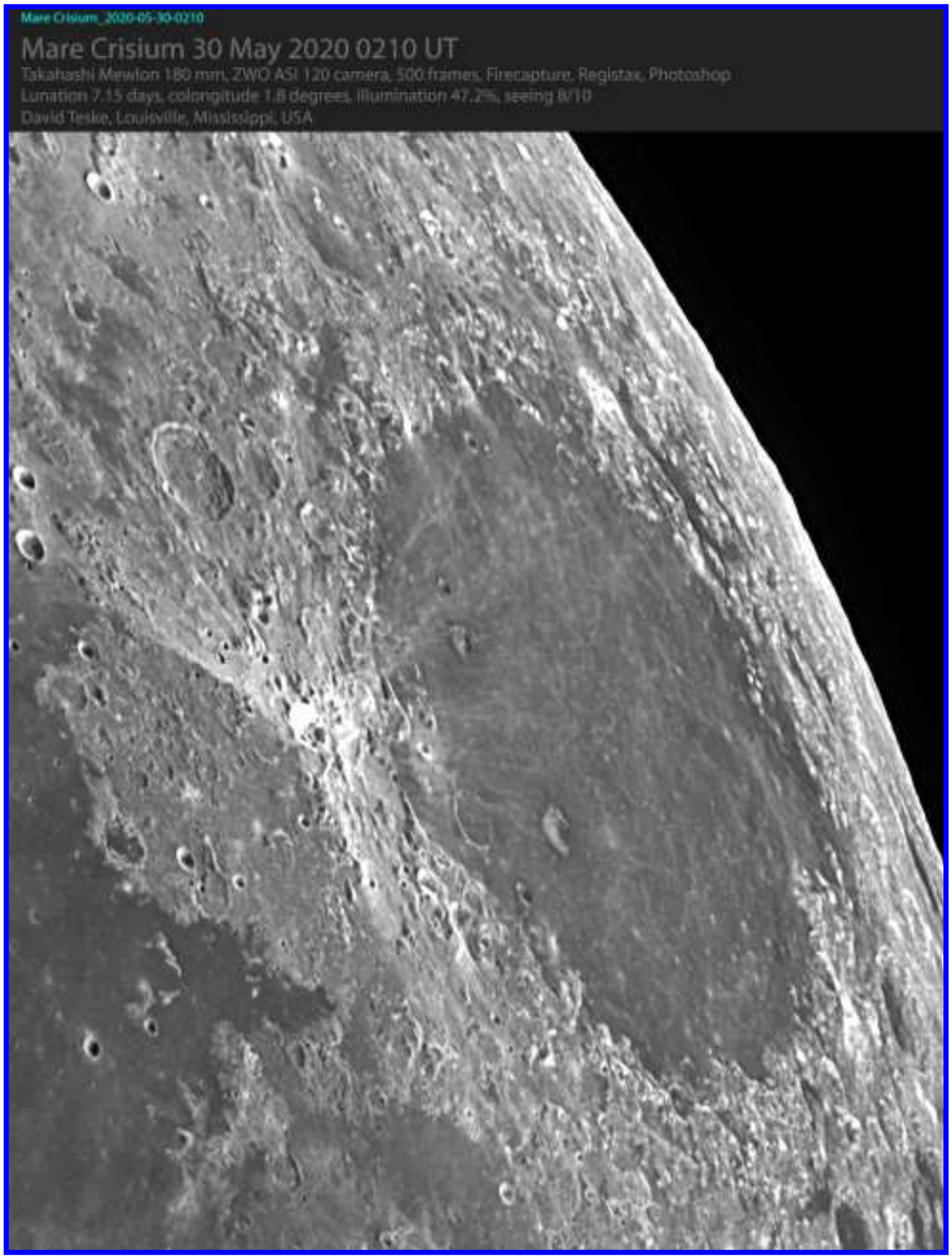


Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2016 July 09 03:06 UT. 8 inch f/20 Maksutov-Cassegrain telescope, 656.3 nm filter, SKYRIS 445M camera. Seeing 8/10.*

INTERIOR

In the interior of our mare, there is a series of medium-sized craters, all in the western half. From south to north we find Greaves (14 km diameter): "The rim crests are sharp and the interior walls are bright. The crater is surrounded by a bright ejecta blanket with some streaks of dull ray materials extending out away from the crater" (Garfinkle, page 341); then Picard (23 km), as described by Elger (page 42): "The largest of the craters on the surface of the Mare Crisium, 21 miles in diameter. The floor, which includes a central mountain, is depressed about 2000 feet below the outer surface, and is surrounded by walls rising some 3000 feet above the Mare", further north we find Peirce (19 km): "This formation, smaller than Picard, is also prominent, its border being very bright. There is a central peak, which, though not an easy object, I once glimpsed with a 4-inch Cook achromatic, and have seen it two or three times since with an 8 ½ in. Calver Reflector" (Elger, page 42). Peirce has a peculiarity: on the northwest rim, depending on the illumination, you can see what appears to be a small crater and in reality, it would be a set of very small crests on a raised part of the rim (a ramp) that with certain illumination would generate illuminated areas and shadows which would be identical to the appearance of a crater (we referred to this in the December 2020 issue of "The Lunar Observer": "The elusive craterlet on the northwest rim of Peirce"). Further north is Swift (12 km): "The crater rises steeply from its rumpled ejecta blanket on Mare Crisium to the north of Peirce. The rim crests are sharp, and the interior walls are steep and bright, and the floor is hummocky" (Garfinkle, page 343).

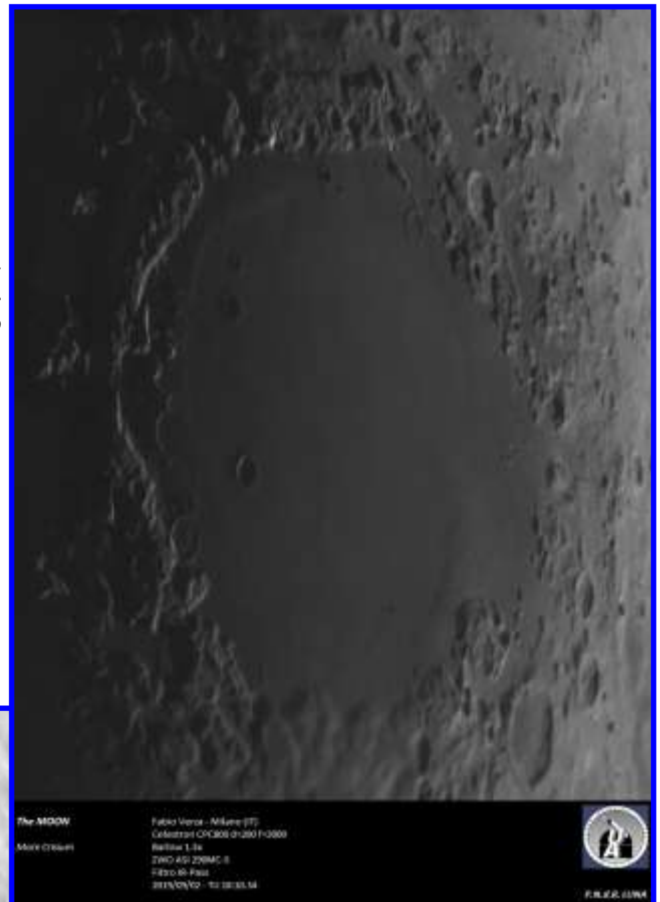
Larger than all of them is Yerkes (36 km), a flooded crater located north of Greaves and east of Picard.



Mare Crisium, *David Teske, Louisville, Mississippi, USA. 2020 May 30 02:10 UT, colongitude 1.8°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mm/s camera. Seeing 8/10.*

Crisium to Marginis, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2021 December 12 01:51 UT, colongitude 7.3°. 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 132M camera. Seeing 7-8/10.*

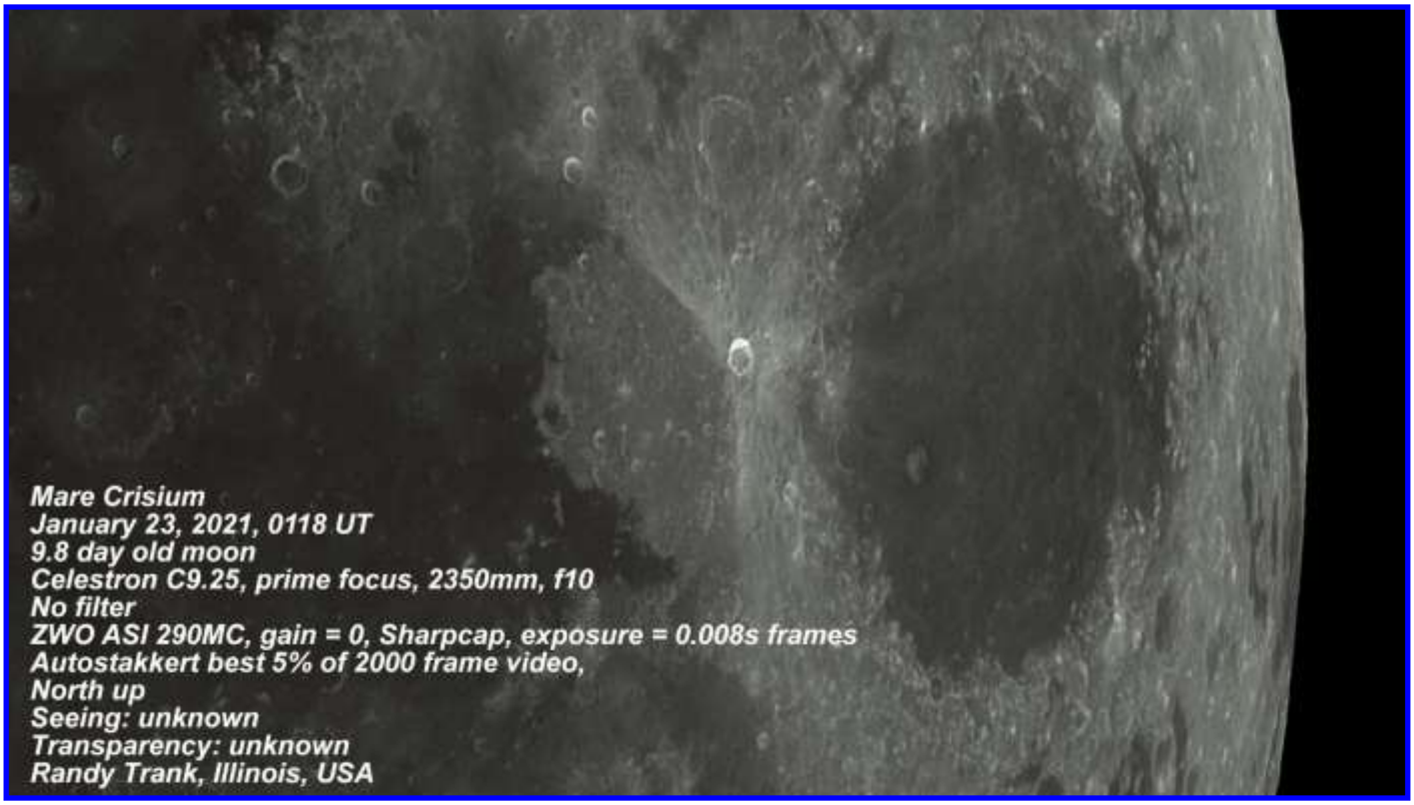
Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2018 October 14 17:32 UT. Celestron 8 inch CPC 800 Schmidt -Cassegrain telescope, 1.3 x barlow, IR pass filter, ZWO ASI290MC/s camera.*



Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2019 September 02 18:10 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, IR pass filter, ZWO ASI290MC/s camera.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2021 January 18 18:13 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, Astronomik IR807 filter, ZWO ASI290MC/s camera.*

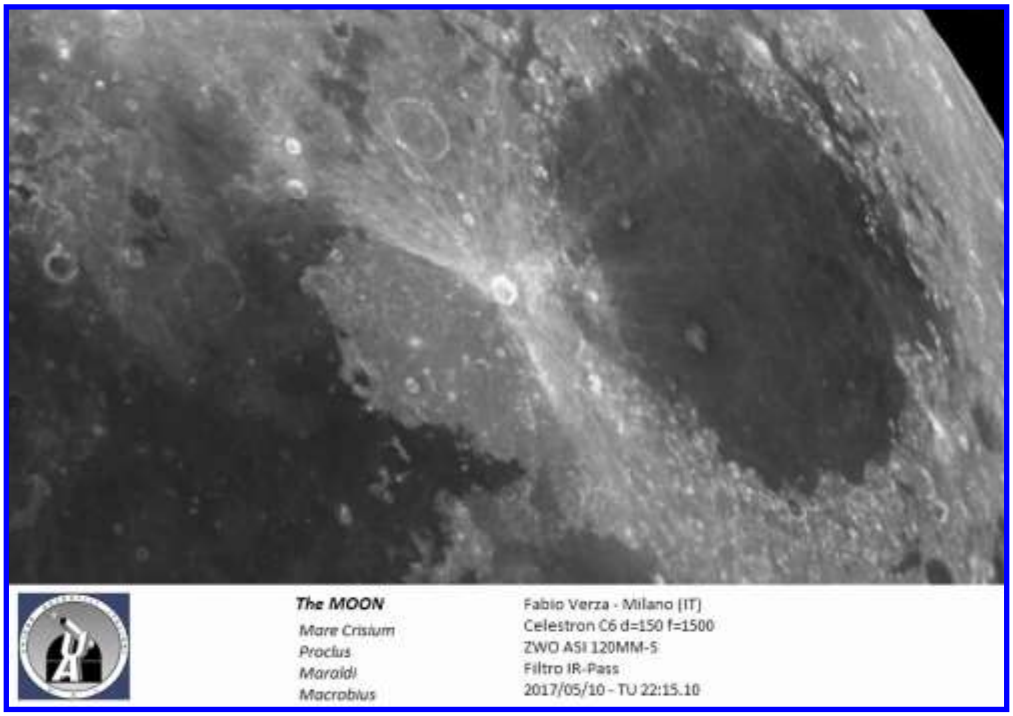
Mare Crisium, *Randy Trank, Illinois, USA. 2021 January 23 01:18 UT. Celestron 9.25 inch Schmidt-Cassegrain telescope, ZWO ASI290MC camera.*



PROCLUS

Mare Crisium is a landscape dominated by one of the most conspicuous craters on the Moon: Proclus, the second brightest crater, although it measures just 28 km in diameter and 2.4 km deep. Proclus is especially known for its bright ray system. Starting on page 93 of "A Modern Moon", Charles Wood analyzes in detail the asymmetrical pattern of its bright rays: "There is a 140º gap in the rays of the southwest side of Proclus, in fact, the countryside to the west of Proclus is noticeably grayer than the ray-covered areas and is one of the few Highland regions of the Moon given a name: Palus Somni, the Marsh of Sleep". The explanation for this "strange region" was not because the "missing rays" had disappeared but because they never existed, but we had to wait until 1978 to find out that the shape of an impact crater depended on the angle of the impact: "No strange ash explosions or mysterious lava veneering of a sunken Palus Somni are required-Palus Somni is simply the ray-excluded zone of the Proclus oblique impact".

Curiously, Proclus would be a small sample of Crisium: "Remember the Crisium basin? It is simply a larger version of Proclus and Messier. The basin's elongated shape, low rims on the east and west, and butterfly-wing-like distribution of ejecta to the north and south are all consistent with the low-angle impact of an asteroid or comet approaching from the west. Wilhelms, who was one of the first to suggest this idea, points out that a number of other basins-Orientale, Imbrium, Humorum, Humboldtianum and Nectaris-also have such asymmetrical features. It is possible that at least some of these oblique impact basins were formed by planetesimals in Earth orbit-leftovers from the formation of the Moon-not by random bombardment of objects that approached the Moon from a wide range of impact angles. Theoretical studies suggest that Earth-orbiting debris would spiral into the Moon, ultimately at low angles" (page 94).



Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2017 May 10 22:15 UT. Celestron 6 inch Schmidt-Cassegrain telescope, IR pass filter, ZWO ASI120mm/s camera.*

There are not many descriptions of the interior of Proclus, overshadowed by the rarity and magnificence of its brilliant ray system. In Elger (page 43) we read that Proclus is “One of the most brilliant objects on the moon's visible surface, and hence extremely difficult to observe satisfactorily. It is about 1 8 miles in diameter, with very steep walls, and, according to Schmidt, has a small crater on its east border, where Mädler shows a break. It is questionable whether there is a central mountain. It is the center of a number of radiating light streaks which partly traverse the Mare Crisium, and with those emanating from Picard, Peirce, and other objects thereon, form a very complicated system”. Today we know that it does not have a central peak (it would not be common in a crater of its size) nor is there a small crater on its eastern wall, its walls are very steep and its floor is littered with rocky mounds.

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2017 July 07 23:51 UT. Celestron 6 inch Schmidt-Cassegrain telescope, 1.3 x barlow, IR pass filter, ZWO ASI120mm/s camera.*

Mare Crisium, Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2008 June 20 07:43 UT. 3.5 inch Questar Maksutov-Cassegrain telescope, 2x barlow, UV/IR blocking filter, SPC900NC camera. Seeing 5/10.

Mare Crisium, David Teske, Louisville, Mississippi, USA. 2020 May 05 02:35 UT, colongitude 56.6°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mm/s camera. Seeing 8/10.

__Mare Crisium,__ David Teske, Louisville, Mississippi, USA. 2020 May 31 02:18 UT, colongitude 14.0°. 180 mm Takahashi Mewlon telescope, ZWO ASI 120 mm/s camera. Seeing 6/10.

__Mare Crisium,__ Fabio Verza, SNdR, Milan, Italy. 2020 August 23 18:41 UT. Celestron 4 inch Nexstar SE Maksutov-Cassegrain telescope, Astronomik IR Pro 807 nm filter, ZWO ASI290MC/s camera.

A MARE WITH WATER

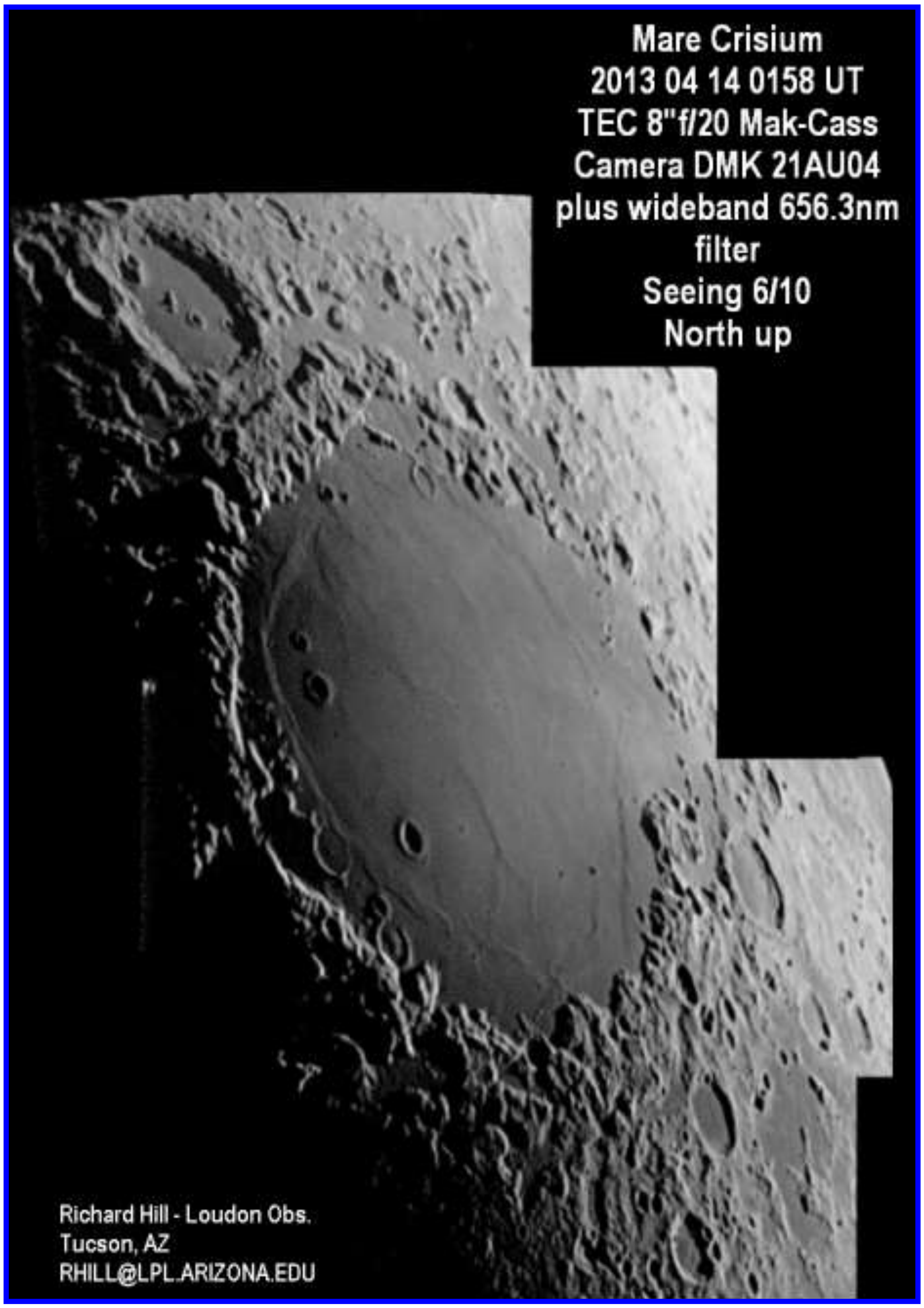
In Mare Crisium landed three Soviet missions from the Luna program, albeit with different luck. Moon 15 was the USSR's attempt to compete with Apollo 11, designed to be the first to automatically collect samples from the lunar surface and bring them back to Earth, but it ended up crashing on July 21, 1969. The feat was accomplished by Moon 16. On November 6, 1974, Moon 23, also designed to bring lunar soil samples to earth, landed in southern Mare Crisium, but the sampling system did not work and three days later contact was lost with the Lander. Finally, Moon 24 landed in southern Mare Crisium on August 18, 1976. The mission was successful and the 170 grams of Mare Crisium soil (at a depth of two meters) reached Siberia on August 22. It was the last Soviet lunar mission, the last controlled moon landing until 2013 (Chang'e 3), and the last mission to collect lunar soil and bring it to Earth until 2020 (Chang'e 5).

But the Luna 24 mission, it seems, discovered water on the Moon. Arlin Crotts unearthed this story in "The New Moon" (page 234): "By the early 1970s the dry Moon was settled science, especially among lunar geologists in the United States. Had that gone differently, the last mission of the Moon Race, by the Soviets, might have changed everything. It discovered water within the Moon. Instead, it was ignored (…) It returned special payload. The core sample was found by scientists M. Akhmanova, B. Dement'ev and M. Markov of the Vernadsky Institute of Geochemistry and Analytic Chemistry to contain about 0.1% water by mass, seen in infrared absorption spectroscopy (at about 3 microns wavelength), a detection about 10 times above the threshold. The water signal tended to increase deeper below the lunar surface. Their papers original title in the February 1978 Russian language journal Geokhimiia translates to "Water in the Regolith of Mare Crisium (Luna 24)?" (…) They indicate the sample shows no tendency to absorb water from the air but are unwilling to stake their reputations on absolute statements on terrestrial contamination being absent. Nonetheless, they claim every possible precaution and stress that this result must be followed up (…). No other author has ever cited the Luna 24 work, as of this writing. A generation passed without further lunar hydration research".

Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2009 July 08 07:38 UT. Celestron 14 inch Schmidt-Cassegrain telescope, 2x barlow, f/22, UV/IR blocking filter, DMK21AU04 camera. Seeing 5/10.*

MARE CRISIUM ON EARTH

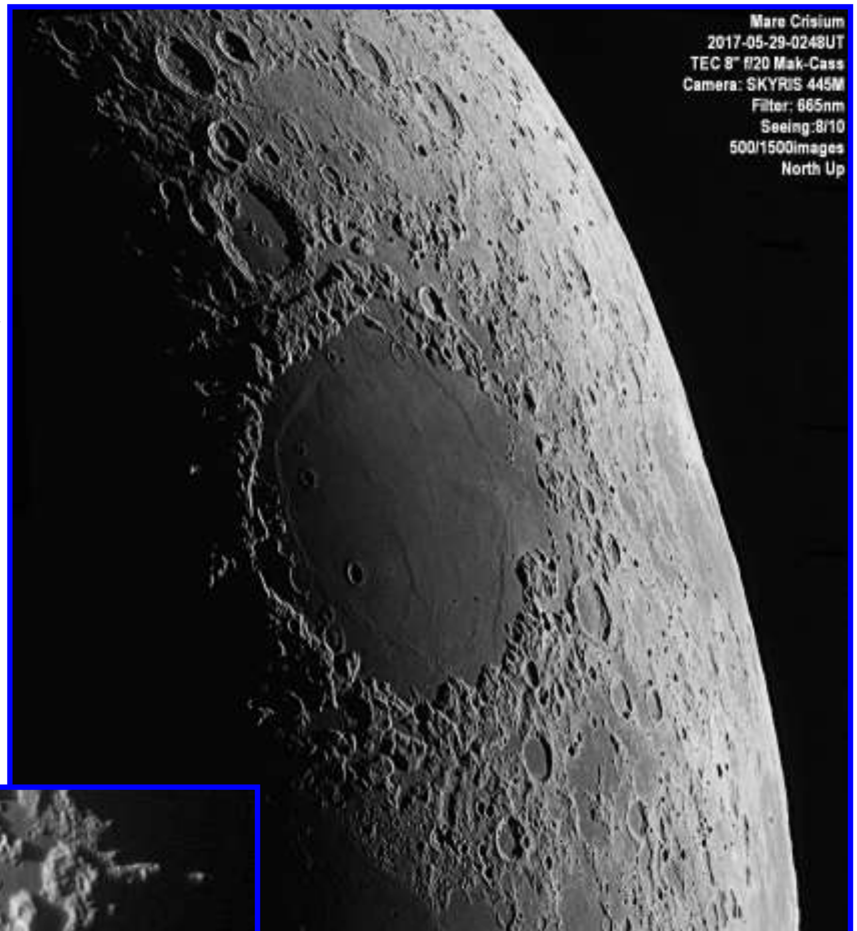
In addition to the 170 grams of Mare Crisium that Luna 24 brought in 1976, on our planet we also have a small part of the edge of our Mare. According to Charles Wood: "A telescopic spectrum of a craterlet on the rim of Eimmart revealed one of the most unusual rock compositions on the Moon. This little crater seems to be very rich in the minerals olivine and pyroxene. Intriguingly the very first lunar meteorite found on Earth (named Allan Hills 81005, usually shortened to AH 81005) has a similar composition. Perhaps the meteorite is a piece of Crisium material ejected by the impact that formed the little crater" (Wood, page 96). Eimmart is a rather peculiar crater, pierced by the bright rays that Eimmart A projects (probably the craterlet that Woods refers to), it is located on the northeast edge, north of Mare Anguis.



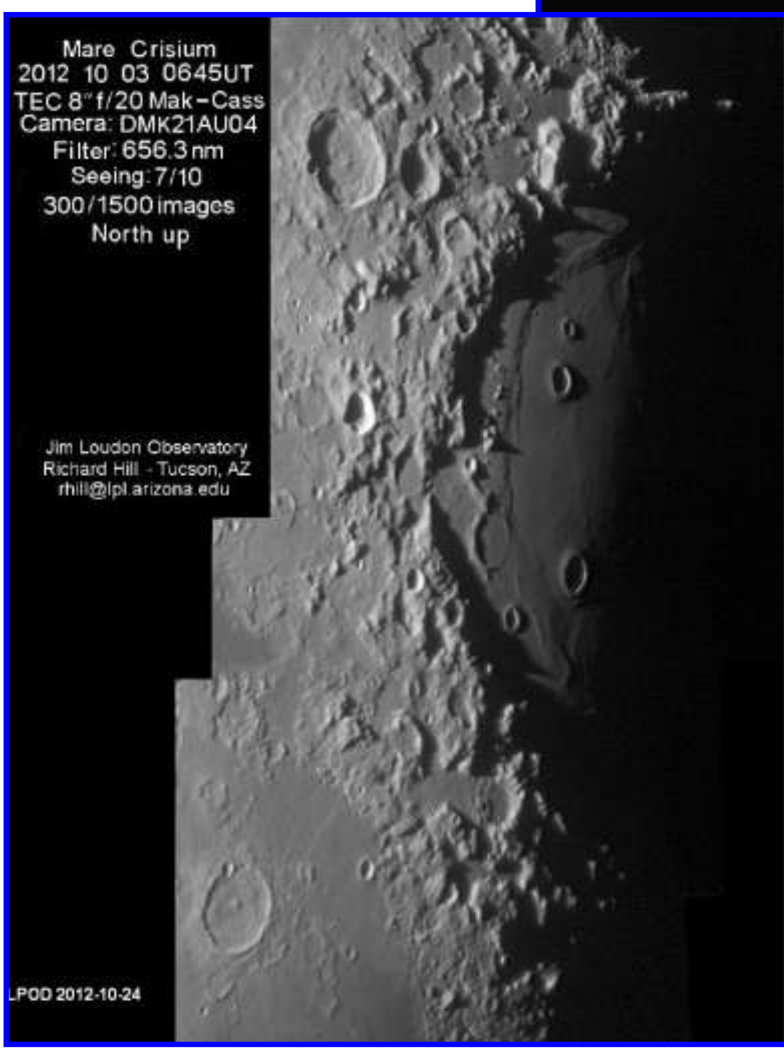
Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2013 April 14 01:58 UT. 8 inch f/20 Maksutov-Cassegrain telescope, 656.3 nm filter, DMK21AU04 camera. Seeing 6/10.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2017 April 29 18:08 UT. Celestron 6 inch Schmidt-Cassegrain telescope, Astronomik 807 IR filter, ZWO ASI120mm/s camera.*

Mare Crisium, *Fabio Verza, SNdR, Milan, Italy. 2018 July 01 00:42 UT. Celestron 8 inch CPC 800 Schmidt-Cassegrain telescope, 1.3 x barlow, Astronomik IR807 filter, ZWO ASI290MC/s camera.*



Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2017 May 29 02:48 UT. 8 inch f/20 Maksutov-Cassegrain telescope, 665 nm filter, SKYRIS 445M camera. Seeing 8/10.*



Mare Crisium, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2012 October 03 06:45 UT. 8 inch f/20 Maksutov-Cassegrain telescope, 656.3 nm filter, DMK21AU04 camera. Seeing 7/10.*

Mare Crisium: A Report From Latin America

Luis Francisco Alsina Cardinalli (Argentina), Alberto Anunziato (Argentina), Sergio Babino (Uruguay), Pablo Contreras (Chile), Jairo Andrés Chavez (Colombia), Román García Verdier (Argentina), Desiré Godoy (Argentina), Eduardo Horacek (Argentina), Eduardo Lara Muñoz (Guatemala), Richard Martin (Uruguay), Jesús Piñeiro (Venezuela), Fernando Surá (Argentina)

When *The Lunar Observer* announced that the objective of the Focus-On Section of the January 2022 issue would be Mare Crisium, from the Sociedad Lunar Argentina and the Sociedad Astronómica Octante (Uruguay) we decided to join in the observation. Mare Crisium is very photographic, we knew that there would be many filed images of this Mare, so we asked the Lunar Section of the Liga Iberoamericana de Astronomía to launch a "LIADA Alert" calling for observation. The result was very positive: new observations came from Uruguay, Guatemala, Venezuela, Argentina, Colombia and Chile. With these observations, part of which make up the main article of this section, we wanted to highlight some of the main characteristics of Mare Crisium and its surroundings.

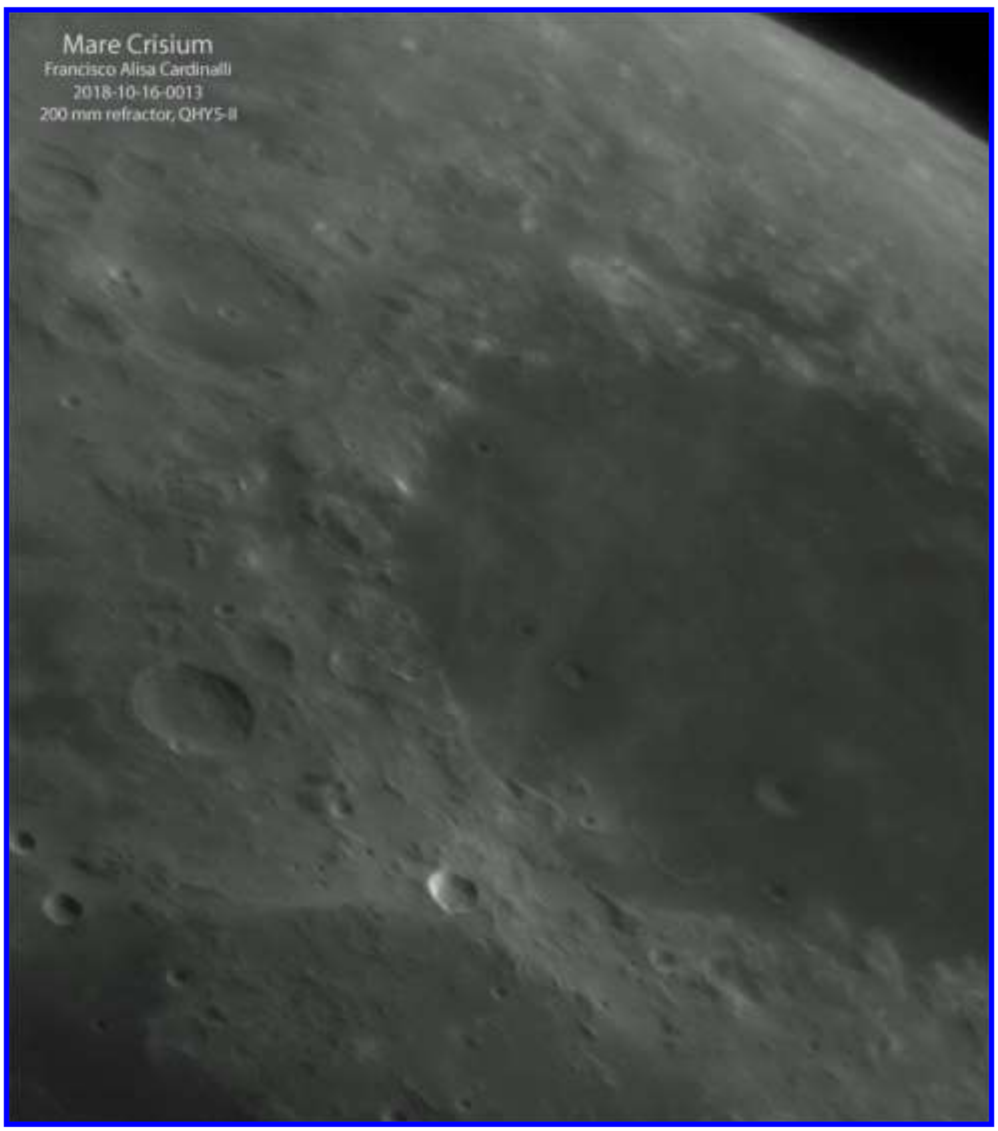


***Image 1. Mare Crisium,** Francisco Alsina Cardinalli, Oro Verde, Argentina. 2018 October 16 00:13 UT. 200 mm refractor telescope, QHY5-II camera.*

Mare Crisium is deep, which can be seen from the height of its edges. In the image by Luis Francisco Alsina Cardinalli (IMAGE 1) we can see the northwest edge of Mare Crisium, which seems to be the only area in which the lava has not completely covered the existing relief, emerging in the form of small elevations that form gorges (IMAGE 1-1). On the north coast we select an almost isolated massif, of which we can see a lot of details despite the fact that the illumination is frontal, the crater on the left is the brightest on the edge of Crisium, we know that it is a crater because we heard Anthony Cook say it in a conference, it shines so bright that it is very easy to mistake it for a Transient Lunar Phenomenon (IMAGE 1-2). The western edge can be seen in its entirety in the image of Fernando Surá (IMAGE 2). The eastern edge appears to be the lowest, especially in the north in Richard Martin's image (IMAGE 3 AND 3-1), but we also find the highest point there, the Promontorium Agarum (3-2). Is the west edge really higher than the east? This is what IMAGE 4 of Jairo Chávez seems to indicate.

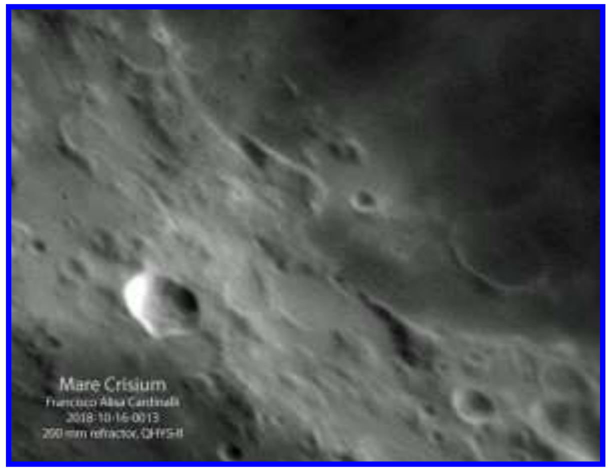


Image 1-1 to right, image 1-2 below. Close-up of Mare Crisium, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2018 October 16 00:13 UT. 200 mm refractor telescope, QHY5-II camera.*

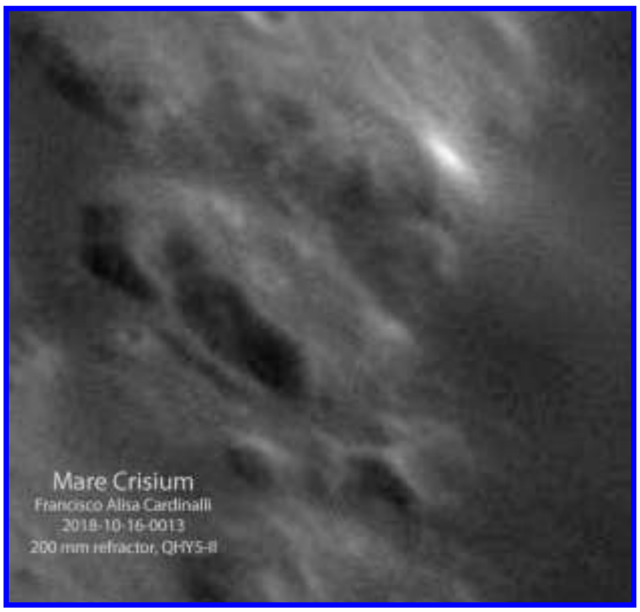


Image 2 right, Mare Crisium, *Fernando Surá, San Nicolás de los Arroyos, Argentina. 2021 November 08 23:28 UT. 127 Maksutov-Cassegrain telescope, J7 cell phone camera.*

Image 3 right, Mare Crisium, *Richard Martin, Canelones, Uruguay. 2021 December 06 23:37 UT. 130 mm reflector telescope, ZWO ASI120mm/s camera.*

Image 3-1 below left, image 3-2 below right, Close-up of Mare Crisium, *Richard Martin, Canelones, Uruguay. 2021 December 06 23:37 UT. 130 mm reflector telescope, ZWO ASI120mm/s camera.*

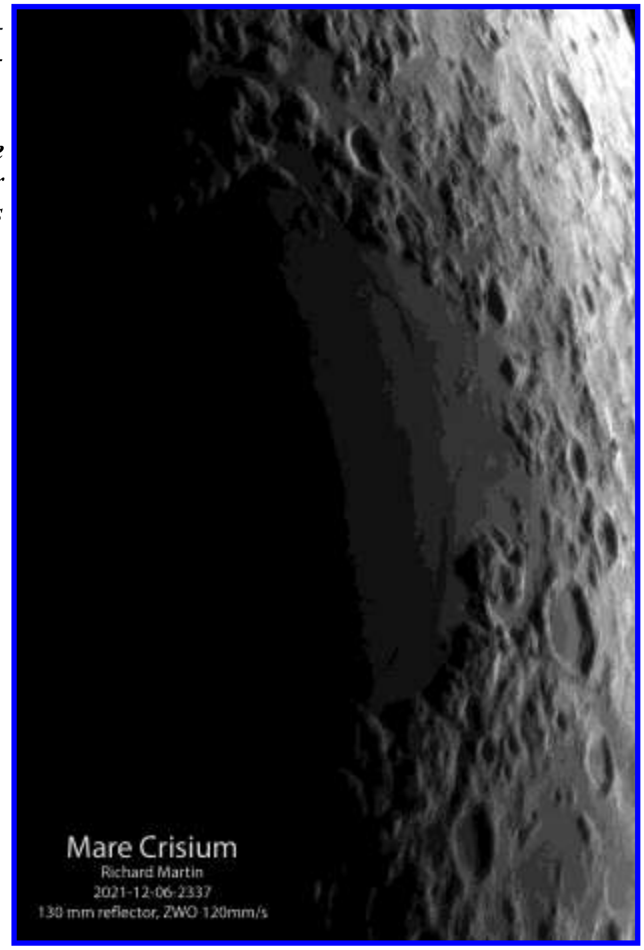


Image 4, Mare Crisium, *Jairo Chavez, Popayán, Colombia. 2021 August 12 00:28 UT. 311 mm truss Dobsonian reflector telescope, MOTO E5 PLAY camera. North up, west right.*

In IMAGES 5 (Luis Francisco Alsina Cardinalli), 6 (Sergio Babino) and 7 (Pablo Contreras) we see how the floor of Crisium appears as covered with a grid of bright bands that are not the rays of the interior craters, as Elger believed. In 5-1, increased in contrast, we can see that the floor of Crisium is not uniform, from west to east some of these bright bands are the rays of Proclus, but not the ones that run from north to south.

Image 5, Mare Crisium, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2017 July 01 23:41 UT. 200 mm refractor telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera.*

Image 6, Mare Crisium, *Sergio Babino, Montevideo, Uruguay. 2019 December 10 01:56 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

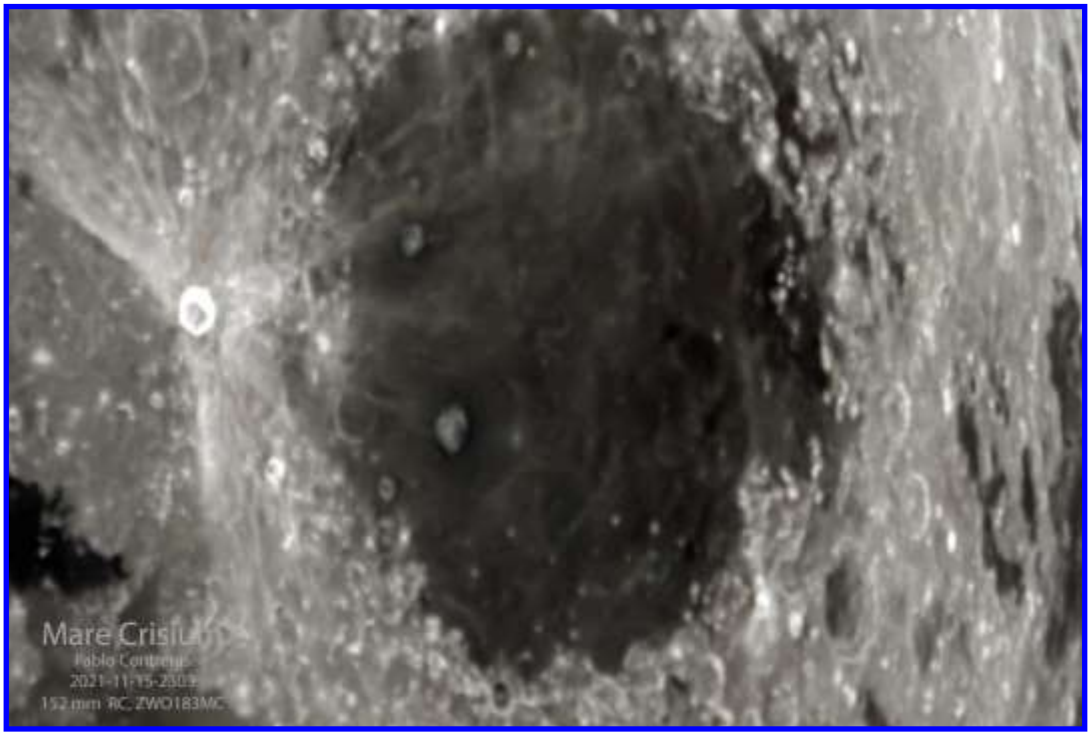


Image 7, Mare Crisium, *Pablo Contreras, Concepción, Chile. 2021 November 15 23:03 UT. 152 mm Ritchey Chrétien telescope, ZWO ASI 183 MC camera.*

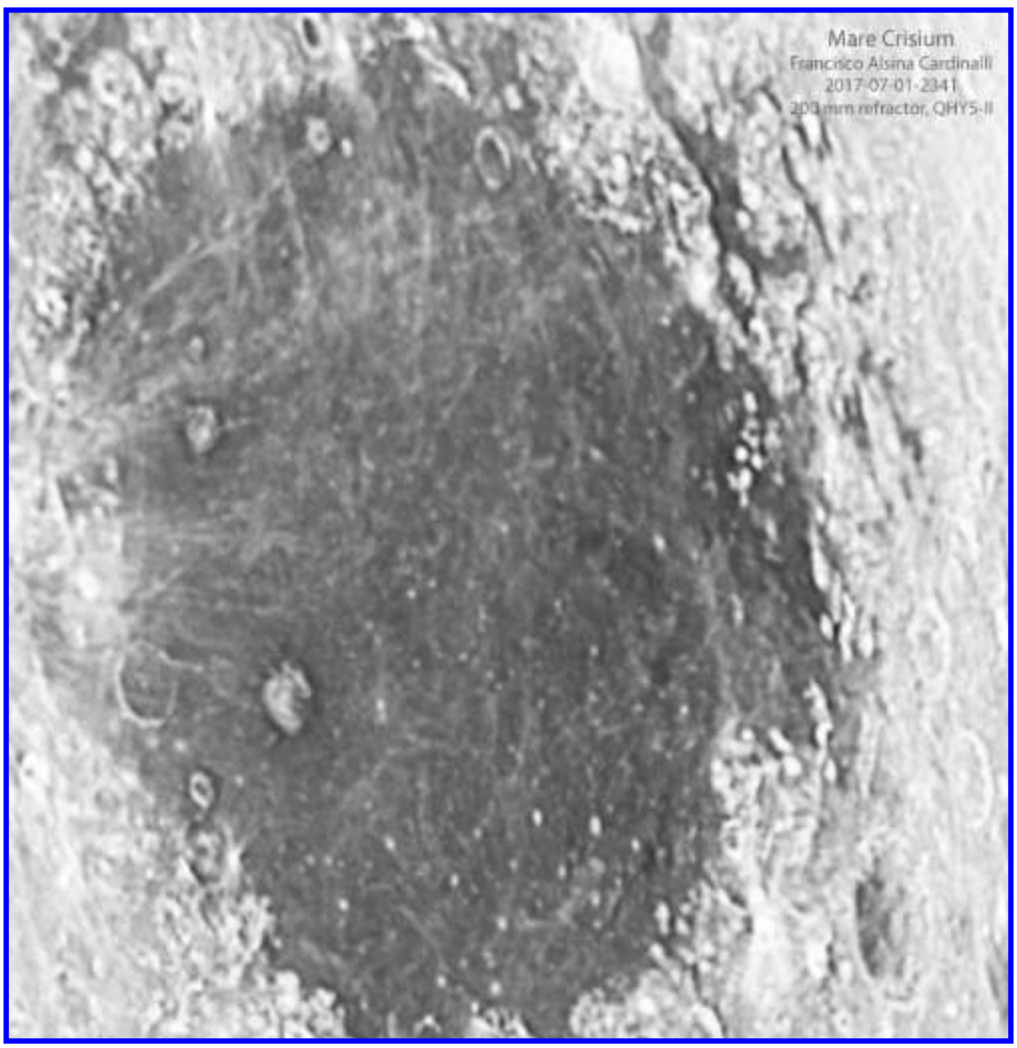


Image 5-1, Mare Crisium, increased contrast, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2017 July 01 23:41 UT. 200 mm refractor telescope, Astronomik ProPlanet 742 nm IR pass filter, QHY5-II camera.*

We also see it with other illumination in IMAGE 8 (Desiré Godoy), only now the darker albedo around the interior craters is more evident, in this case around Greaves and Picard, the interior topography of the flooded crater Lick is also interesting. In IMAGE 9 (Pablo Contreras) we see that all the craters within Crisium have a dark albedo area around them.

Image 8, Mare Crisium, *Desiré Godoy, Oro Verde, Argentina. 2020 August 28 23:53 UT. 200 mm refractor telescope, QHY5-II-camera.*

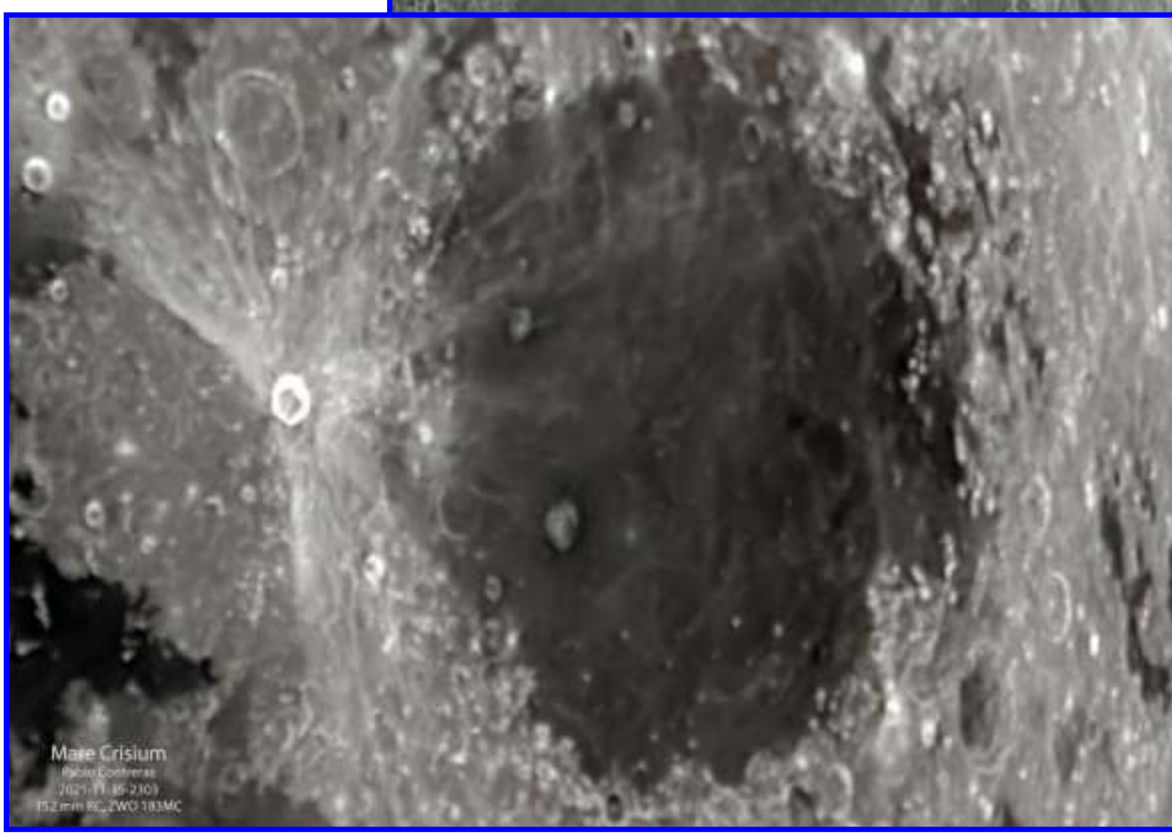


Image 9, Mare Crisium, *Pablo Contreras, Concepción, Chile. 2021 November 15 23:03 UT. 152 mm Ritchey Chrétien telescope, ZWO ASI 183 MC camera.*

As for the different lava units present inside Crisium, we can see them in Desiré Godoy's images (10 and 11), where we see the darkest edge (which according to Wood in "Modern Moon" indicates the oldest lava). Image 12 (Sergio Babino) shows the complete map of the different units of lava that make up the floor of Crisium.

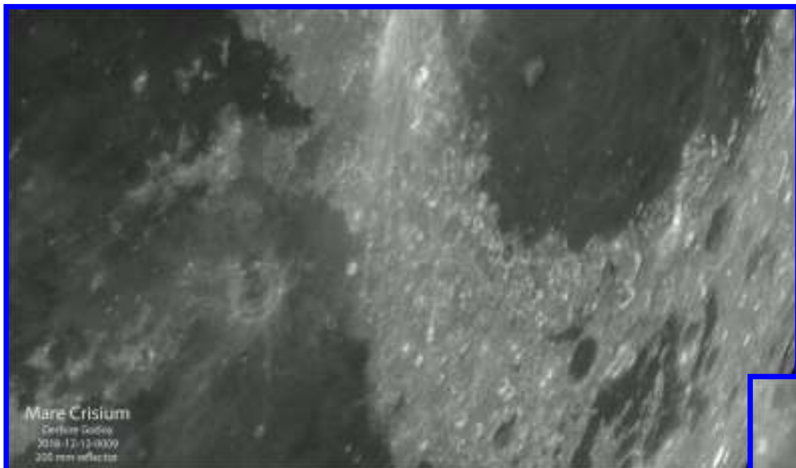


Image 10, Mare Crisium, *Desiré Godoy, Oro Verde, Argentina. 2016 December 16 00:09 UT. 200 mm Meade Starfinder reflector telescope, Astronomik ProPlanet 742 nm IR pass filter .*

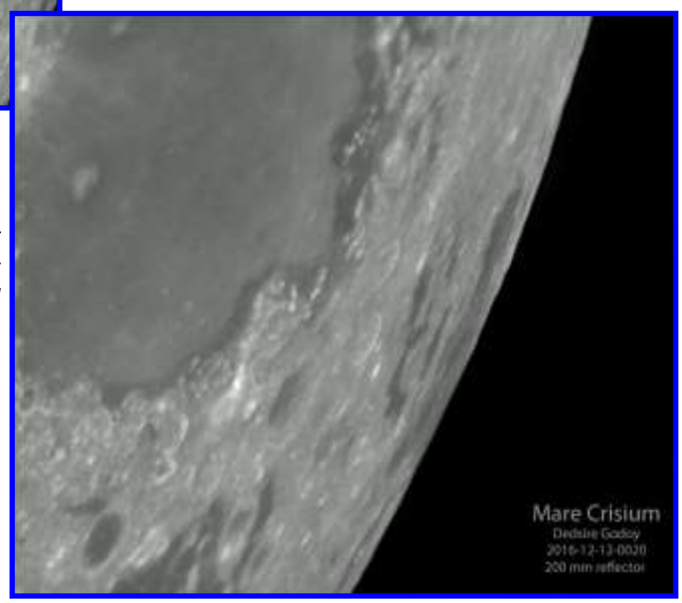


Image 11, Mare Crisium, *Desiré Godoy, Oro Verde, Argentina. 2016 December 16 00:20 UT. 200 mm Meade Starfinder reflector telescope, Astronomik ProPlanet 742 nm IR pass filter .*

Image 12, Mare Crisium, *Sergio Babino, Montevideo, Uruguay. 2019 December 10 01:56 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

Regarding the wrinkle ridges of the Mare Crisium, low and difficult to observe, the image of Jesús Piñeiro (13) shows them with illumination from the east, like in the images from Eduardo Horacek. IMAGE 14 and 15 (in which the terminator passes through the west edge, it is the ideal moment to observe the central wrinkle ridges) and in the IMAGE 16 of Eduardo Lara Muñoz. In IMAGE 17 (Alberto Anunziato) the terminator passes through the center, illuminated from the west, the central wrinkle ridge is observed, but especially the Dorsum Oppel (west edge). In Richard Martin's IMAGES (3, 18 and 19) we see the eastern edge, dominated by the Dorsa Harker.

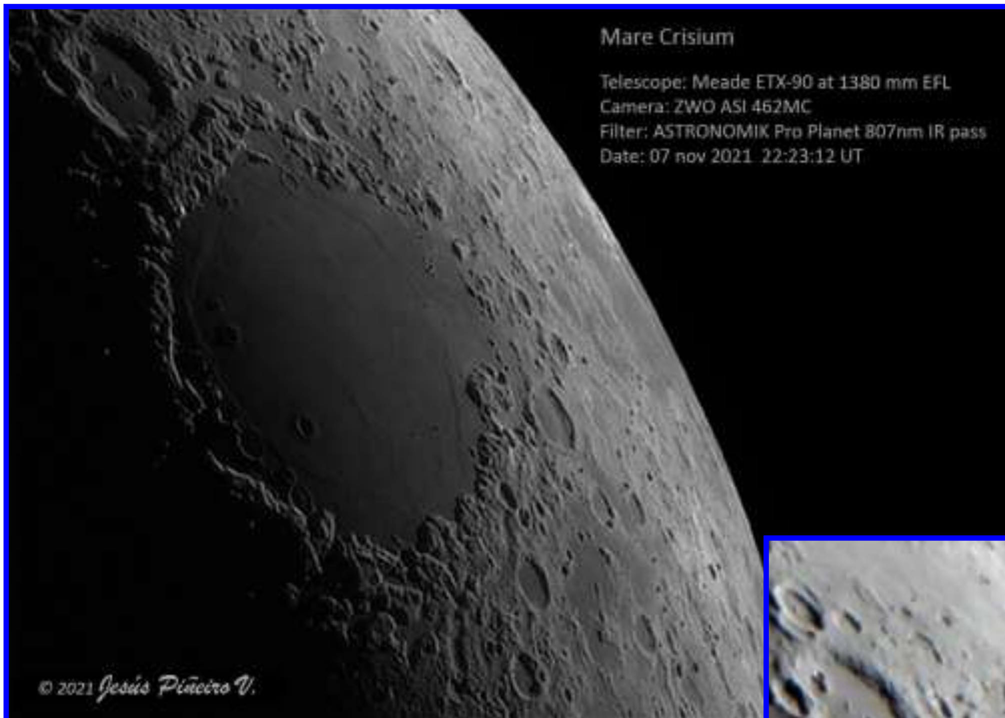


Image 13, Mare Crisium, *Jesús Piñeiro, San Antonio de los Altos, Venezuela. 2021 November 07 22:23 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, Astronomik ProPlanet 807 nm IR pass filter, ZWO ASI462 MC camera.*

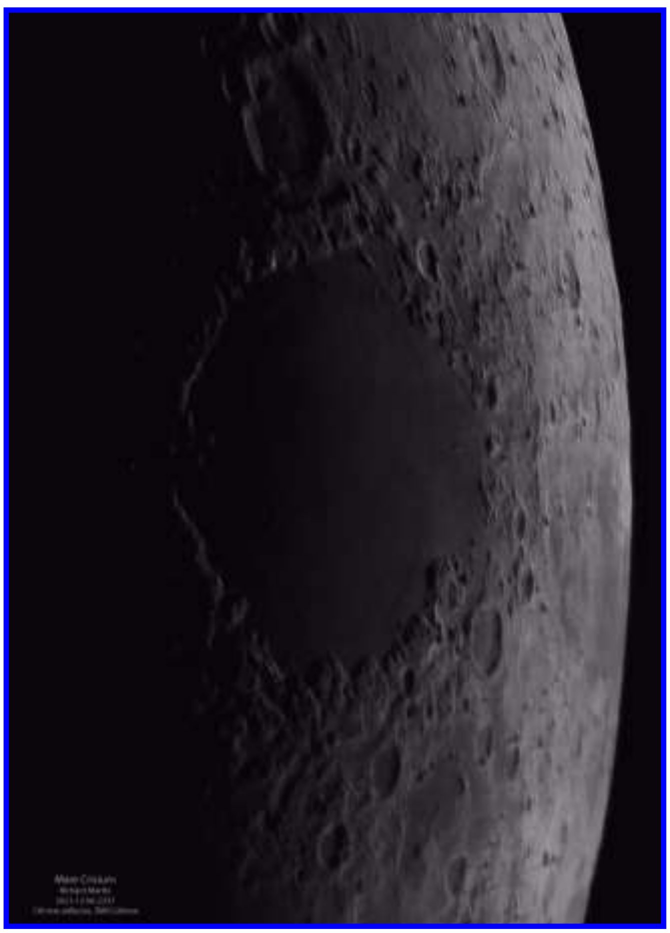
Image 14, Mare Crisium, *Eduardo Horacek, Mar del Plata, Argentina. 2020 October 09 23:15 UT. 150 mm Maksutov-Cassegrain telescope, Canon EOS Rebel T5i camera.*

*Image 15, **Mare Crisium,** Eduardo Horacek, Mar del Plata, Argentina. 2020 October 09 23:54 UT. 150 mm Maksutov-Cassegrain telescope, Canon EOS Rebel T5i camera.*

*Image 16, **Mare Crisium,** Rafael Lara Muñoz, Guatemala, Guatemala. 2021 October 09 00:35 UT. 114 mm Newtonian reflector telescope, Samsung Note 20 cell phone camera.*

***Image 17, Mare Crisium,** Alberto Anunziato, Oro Verde, Argentina. 2018 February 03 05:48 UT. Celestron CPC1100 Schmidt-Cassegrain telescope, Canon EOS Digital Rebel XS.*

***Image 18 below left, image 19 below right, Close-up of Mare Crisium,** Richard Martin, Canelones, Uruguay. 2021 December 06 23:37 UT. 130 mm reflector telescope, ZWO ASI120mm/s camera.*



In 13-1 (detail of the image of Jesús Piñeiro), we see quite clearly the two domes mentioned by Raffaello Lena in the now classic study by him.

Image 13, Mare Crisium close-up, *Jesús Piñeiro, San Antonio de los Altos, Venezuela. 2021 November 07 22:23 UT. Meade ETX 90 mm Maksutov-Cassegrain telescope, Astronomik ProPlanet 807 nm IR pass filter, ZWO ASI462 MC camera.*

In IMAGES 20 (Román Garcia Verdier) and 21 (Pablo Contreras) we can see the bright ray system of Proclus and the contrast with the area known as Palus Somni, which in turn presents a darker area (east) and another brighter (west), as seen in IMAGE 6 by Sergio Babino.

Image 20, Mare Crisium, *Román García Verdier, Paraná, Argentina. 2020 November 01 04:31 UT. 180 mm Newtonian reflector telescope, QHY5-II camera.*

Image 21, Mare Crisium, *Pablo Contreras, Concepción, Chile. 2021 November 15 23:03 UT. 152 mm Ritchey Chrétien telescope, ZWO ASI 183 MC camera.*

In IMAGES 22 and 23 (Alberto Anunziato) we see that there is a brighter Proclus ray, which can be seen even with the terminator very close (as is the case with the brighter Mädler ray).

Image 22, Mare Crisium, *Alberto Anunziato, Oro Verde, Argentina. 2016 September 18 04:05 UT. Meade 10 inch LX200 Schmidt-Cassegrain telescope, SPC900NC camera.*

Image 23, Mare Crisium, *Alberto Anunziato, Oro Verde, Argentina. 2015 November 28 05:29 UT. Meade 10 inch LX200 Schmidt-Cassegrain telescope, SPC900NC camera.*

In a detail of IMAGE 24 by Sergio Babino, we see with unusual clarity what is impossible for visual observers as experienced as Elger to observe: the extraordinarily complicated topography of the bottom of Proclus its bottom, full of mounds, some as high as to cast a shadow, one of Proclus's notorious bright rays seems to emerge from one of them, projecting over the eastern rim and even continuing beyond, analogously to Anaxagoras. In the next detail of the same image (24-2) we see how the bright rays from Proclus are projected over the nearby craters, to the west, creating the sensation of a high wall of a banded crater. Another detail (24-3) of image 24, shows us another system of bright rays close to Crisium, of course much less extensive and less prominent than that of Proclus, that of Eimmart A, whose rays project towards the west within Eimmart, giving it a similar shape to a seashell, which can also be seen in the detail of image 1 by Luis Francisco Alsina Cardinalli (IMAGE 1.3). Eimmart is the crater that Woods mentions as the source of the first meteorite from the Moon found on Earth. Visually it is observed that in image 25 (from an observation for the Project for the Verification / Elimination of Historical Reports of Transient Lunar Phenomena "(ALPO / BAA / University of Aberystwyth), Eimmart A is very bright with frontal light, of Eimmart we could only observe the bright rays, that look like very bright bands, but they are rays coming from Eimmart A.

Image 24, Mare Crisium, *Sergio Babino, Montevideo, Uruguay. 2020 November 21 22:29 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

Image 24-1, ***Mare Crisium, close up of Proclus,*** *Sergio Babino, Montevideo, Uruguay. 2020 November 21 22:29 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

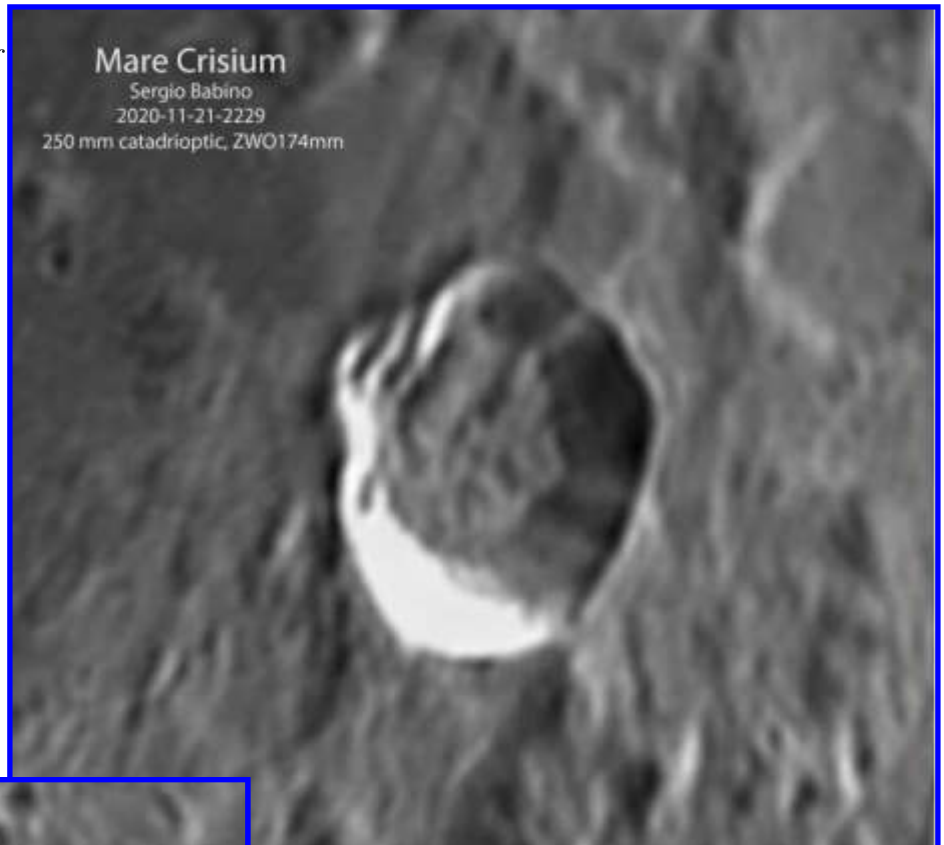


Image 24-2, Mare Crisium, close up of rays of Proclus, *Sergio Babino, Montevideo, Uruguay. 2020 November 21 22:29 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

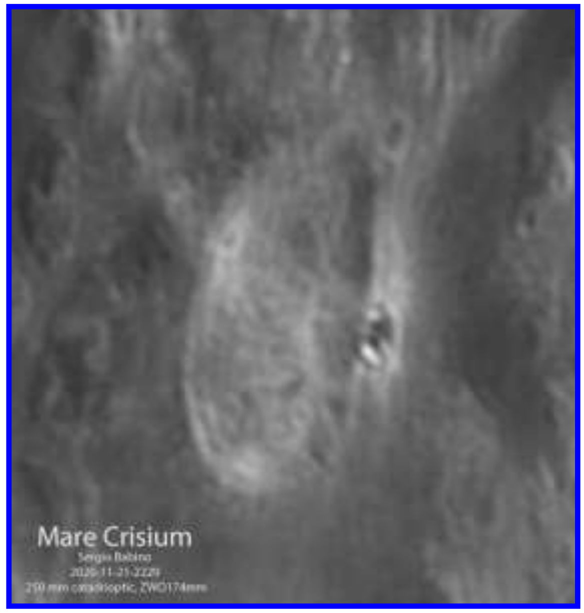


Image 24-3, Mare Crisium, close up of rays of Eimmart, *Sergio Babino, Montevideo, Uruguay. 2020 November 21 22:29 UT. 250 mm catadrioptic telescope, ZWO ASI174mm camera.*

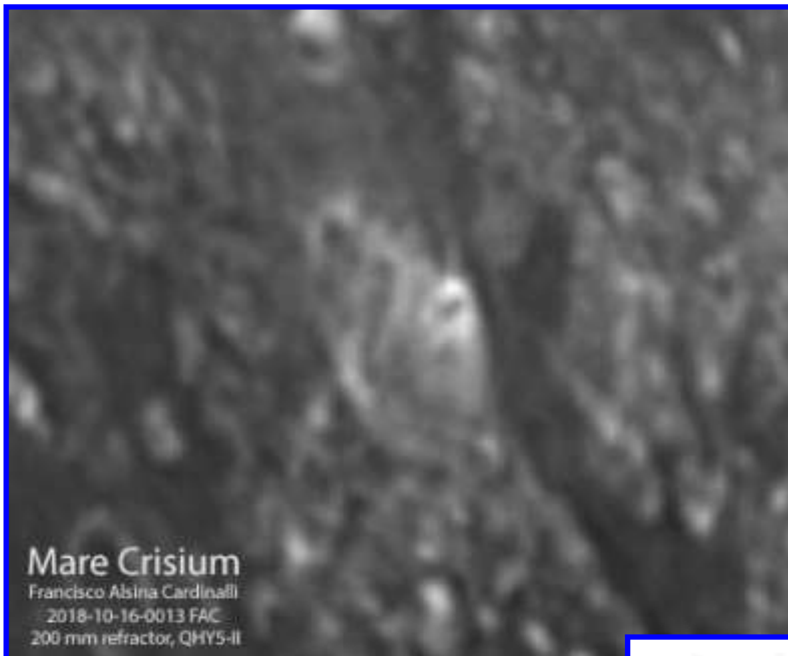


Image 1-3. Close-up of Mare Crisium, Eimmart A, *Francisco Alsina Cardinalli, Oro Verde, Argentina. 2018 October 16 00:13 UT. 200 mm refractor telescope, QHY5-II camera.*

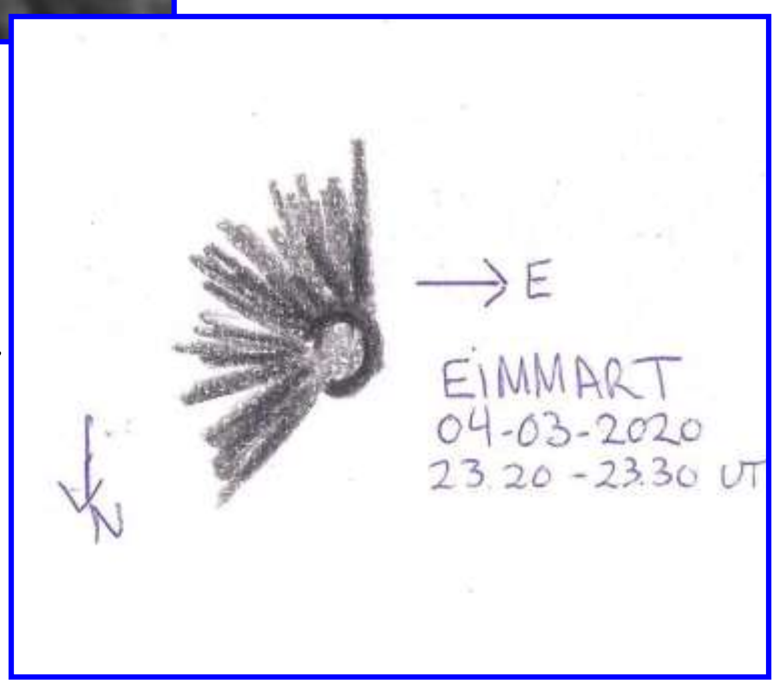
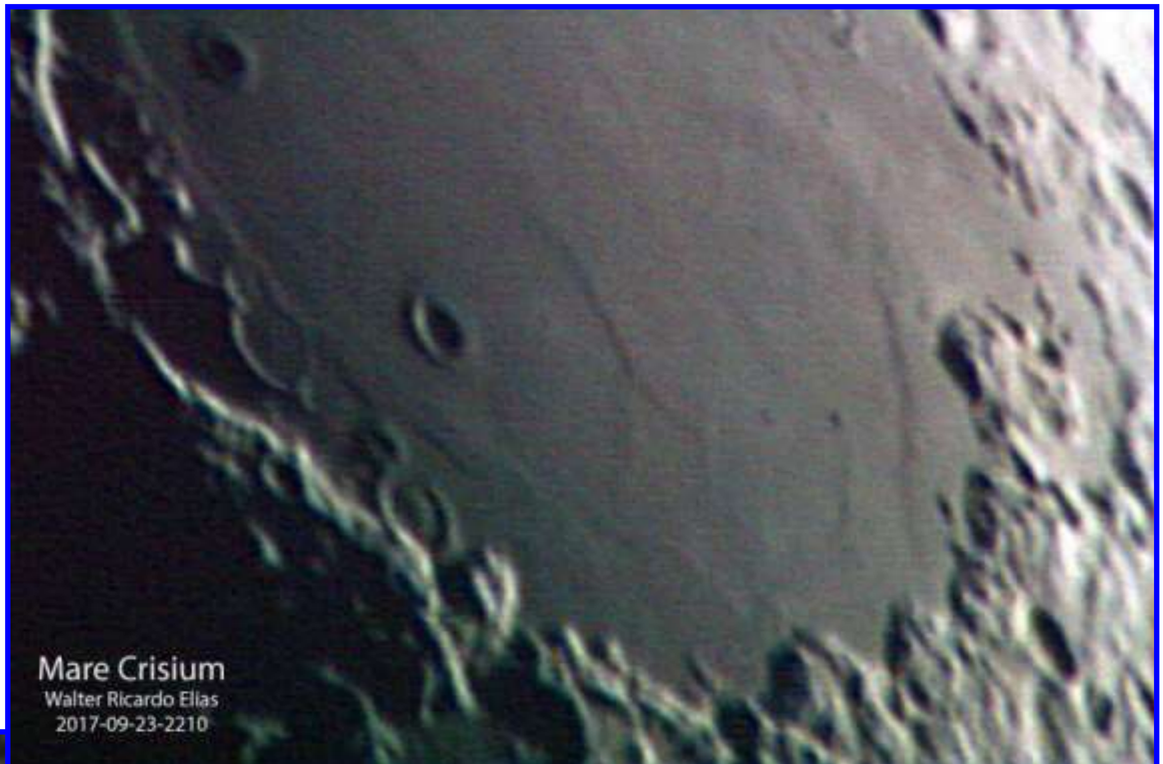
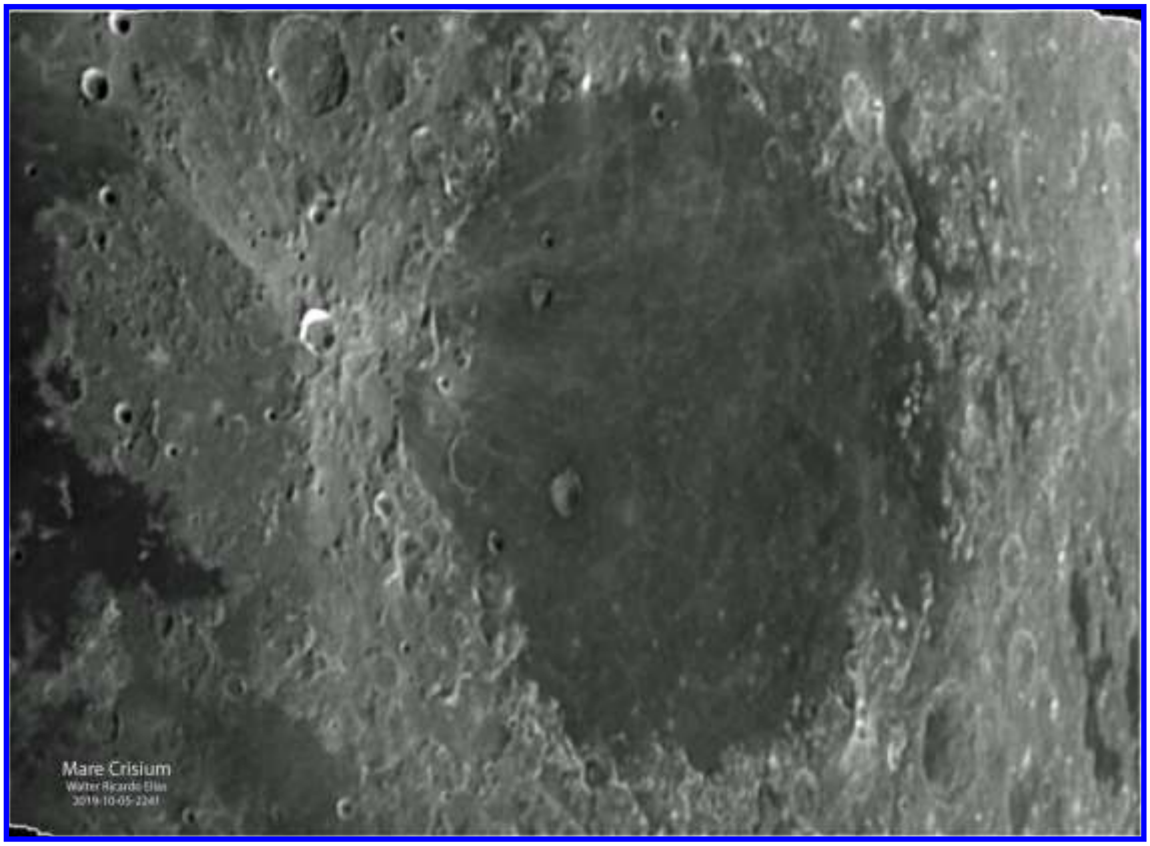


Image 25, Eimmart, *Alberto Anunziato, Paraná, Argentina. 2020 April 03 23:20-23:30 UT. Meade EX105 mm Maksutov-Cassegrain telescope, 154 x.*

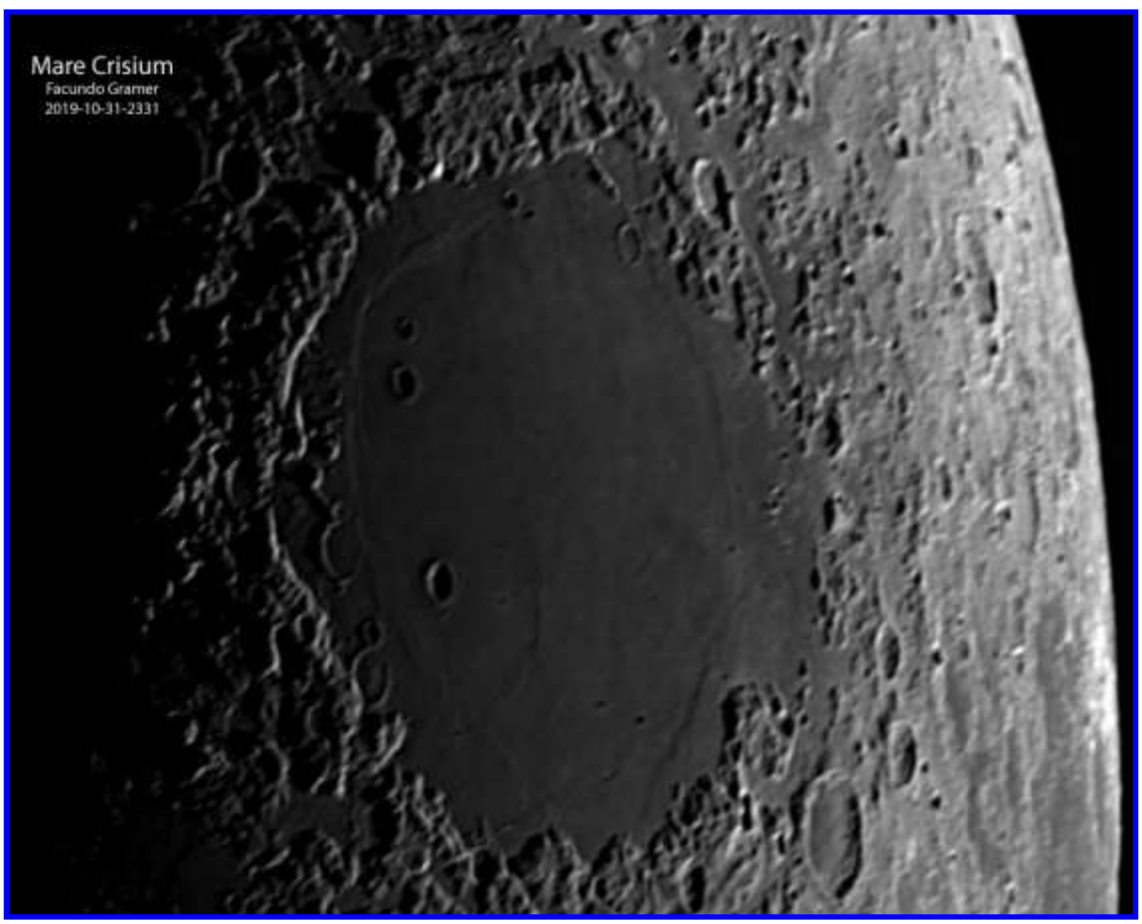


Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2017 September 23 22:10 UT.*

Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2018 March 20 19:53 UT.*



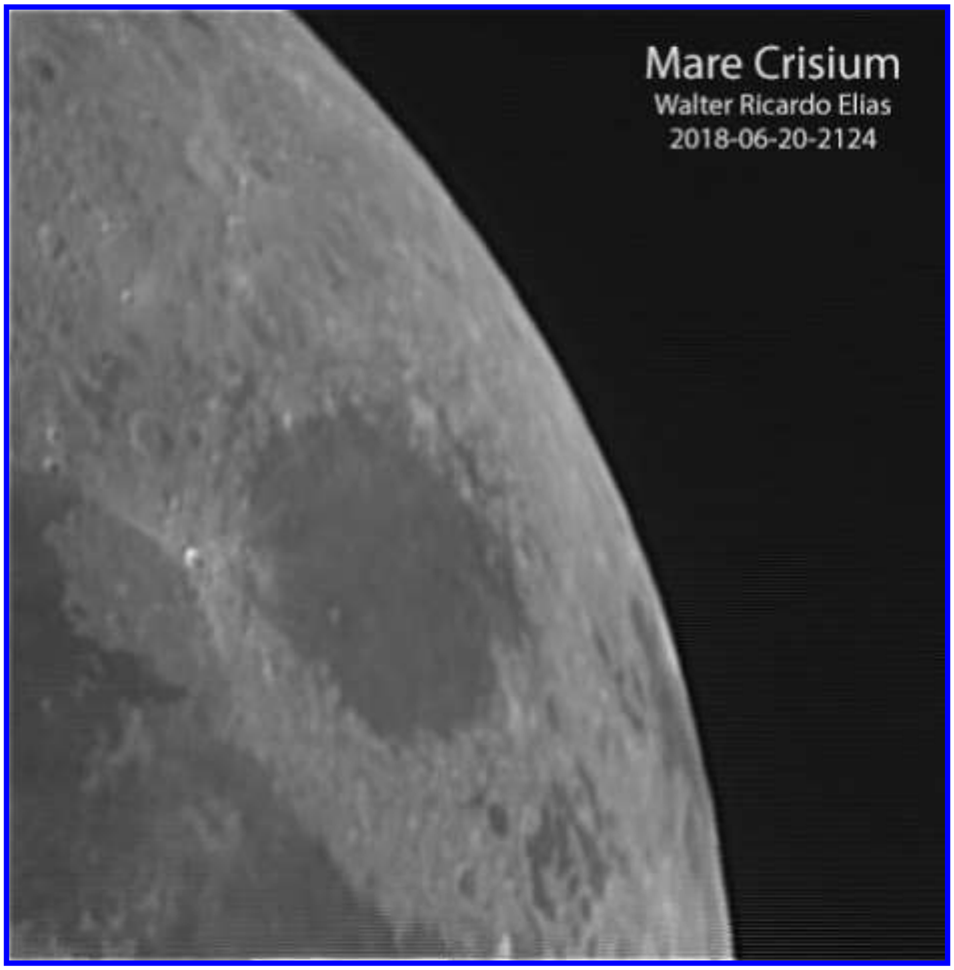
Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2019 October 05 22:41 UT.*



Mare Crisium, *Facundo Gramer, AEA, Oro Verde, Entre Rios, Argentina. 2019 October 31 23:31 UT.*

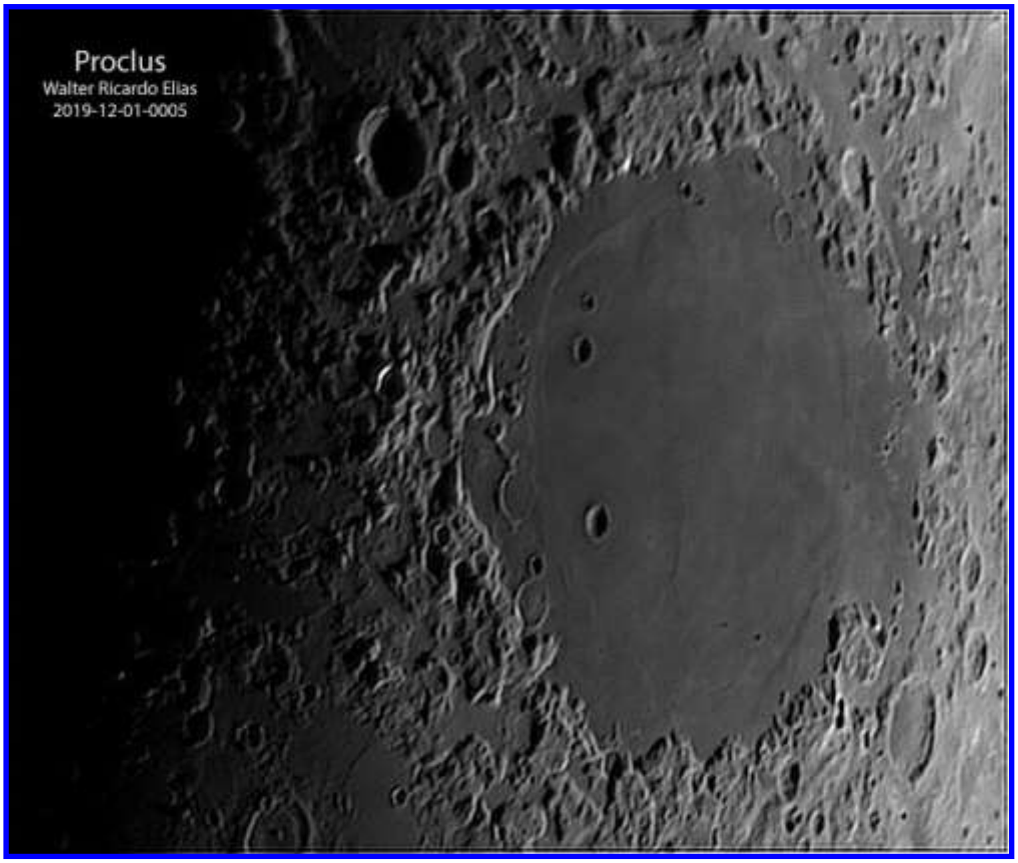
Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2019 December 13 03:08 UT.*

Mare Crisium, *Facundo Gramer, AEA, Oro Verde, Entre Rios, Argentina. 2020 January 10 01:15 UT.*



Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2018 June 20 21:24 UT.*

Mare Crisium, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2018 February 03 05:48 UT.*



Proclus, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2019 December 01 00:05 UT.*

Proclus, *Victoria Gomez, AEA, Oro Verde, Entre Rios, Argentina. 2019 December 04 23:17 UT.*

***Proclus,** Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2019 December 07 03:36 UT.*

***Proclus,** Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2020 January 06 23:21 UT.*

Proclus, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2020 January 06 23:23 UT.*

Proclus, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2020 January 30 23:24 UT.*

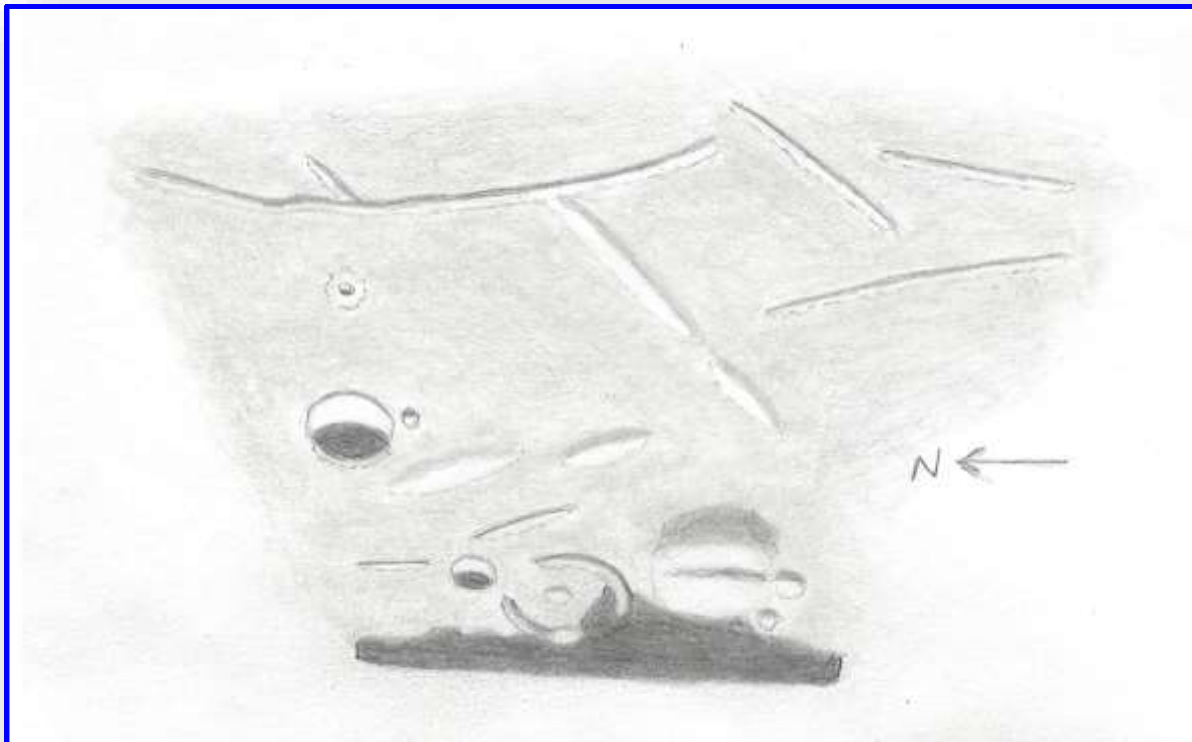
Proclus, *Gabriel Re, AEA, Oro Verde, Entre Rios, Argentina. 2020 March 03 01:43 UT.*

Proclus, *Walter Ricardo Elias, AEA, Oro Verde, Entre Rios, Argentina. 2020 March 08 23:19 UT.*

Mare Crisium, *Christian Viladrich, France. 2021 September 23 05:06 UT. Astrosib 500 mm Ritchey Chretien telescope, IR 685 nm filter, ZWO ASI290 camera. North down, west right.*

Picard and Southwest Mare Crisium

Robert H. Hays, Jr.



Picard and Southwest Mare Crisium*, Robert H. Hays, Jr., Worth, Illinois, USA. 2021 October 23 08:45-09:39 UT. 15 cm reflector telescope, 170 x. Seeing 7-8/10, transparency 6/6.*

I observed this area on the morning of October 23, 2021. Picard is the largest crater in this sketch. This is a fairly large, crisp crater with a small peak just to its south. The crater Lick D to the southwest is a smaller version of Picard. Lick itself is south of Lick D and at the edge of Mare Crisium. Lick is larger than Picard, but its northeast rim is missing. Lick also has a rounded central peak. The nearby shadows are from rugged terrain at the edge of Mare Crisium. A strip of sunlit rim protrudes into a shadowed area. A large, nearly round mountain is south of Lick. This mountain is bisected by a strip of shadow, and two small peaks are just to its south. Two narrow ridges are southeast and north of Lick D, and two wider but lower ridges are south of Picard. The bright spot east of Picard contains the pit Picard Z. There is a network of ridges or wrinkles east and south of Picard. A 'Y' intersection is southeast of Picard. The longest ridge is nearly straight northward from this intersection before petering out. A short branch extends eastward from it near Picard Z. A wider but lower ridge goes southwest from the 'Y', ending south of the large mountain. There is a gap a little more than halfway along its length. The ridge south of the 'Y' is narrower but with darker shadowing than the one to the east. Three narrow, very straight ridges are farther to the south. All showed similar, modest shadowing. One is oriented northeast-southwest, and is nearly but not quite parallel to the one west of the 'Y'. Two similar ridges are nearly north-south, but are not parallel to each other. All these ridges are detached from each other and from the main ridge.

A Tale of Two Mare

Rik Hill

This is a much larger portion of the moon and higher sun than I usually do but it shows some seldom seen features well thanks to a favorable libration. Of course, the "elephant in the room' is Mare Crisium (638 km dia.) on the left side of the image with the bright rayed crater Proclus (29 km) on the west side (left) of the Mare. On the south edge of this image is dark floored crater Firmicus (58 km) and next to it are the northern fingers of Mare Undarum. Move back towards the southern edge of Crisium you will see a large crater with a floor that is half dark. This is Condorcet (77 km) with Hansen (41 km) just to the right or east of it.

Notice the backwards "3" just outside the upper right edge of Crisium. This is Mare Anguis (130 km x 30 km). It's listed as 134 km diameter but is anything but circular! Totally unassociated but south of this and further east of Crisium is another bit of mare material of the same shape and orientation as Anguis. Curious but no more than that. However, it leads us to the larger patch of mare material that is Mare Marginus, not usually seen this well. On the south end of this Mare, you can see most of the northern two thirds of the large dark floored crater Neper (141 km) with its bright central peak. Note on the opposite side of Marginis, on the north side there is a very oval dark feature that is the crater Goddard (92 km). Then further north, well outside Marginis, is another dark floored crater Hubble (83 km). On the limb north of this is our last crater, Liapunov (68 km) visible only at favorable librations like this one.

Crisium to Marginis, *Richard Hill, Loudon Observatory, Tucson, Arizona, USA. 2021 December 12 01:51 UT, co-longitude 7.3°. 8 inch f/20 Maksutov-Cassegrain telescope, 610 nm filter, SKYRIS 132M camera. Seeing 7-8/10.*

Mare Crisium in the Golden Ages

David Teske

In the pages above, we have seen excellent images of Mare Crisium, all taken by modern amateur astronomers using relatively modest telescopes. All of the images were taken using digital cameras or drawings. The largest telescope used was 500 mm (~18 inches) but most images were taken with much smaller telescopes, 4 to 14-inch range. They are truly remarkable images.

For this essay, I thought I would look back to my older Lunar atlases, to see what they showed of the Mare Crisium area. Some of these older atlases are long out of print, but some still are in print. Some of these atlases were made at the time of great lunar exploration in preparation for the Apollo landings to come. Some dated prior to that time; other past that time. In a way, I see this as the golden age of lunar observing, when the many details of lunar topography were getting fully flushed out.

__Image 1__ Patrick Moore, New Guide to the Moon, 1976.

I start with where I started, in 1976 with Patrick Moore's book <u>New Guide to the Moon</u>. I was just a youngster then, and had this book ordered from a local bookstore. I guess now that started a trend in my life! After a few long weeks at the high price of $10.95, the book finally arrived. Image 1 is of the book cover, image 2 is Moore's map of Mare Crisium. Not bad, but hardly detailed. I believe Patrick Moore did most of his lunar observing with a 12.5-inch reflector. Looking back, it certainly was not the best lunar book, but it did get me interested in lunar studies. In 2002, I purchased an updated edition of this book, Patrick Moore on the Moon, which I believe is still available.

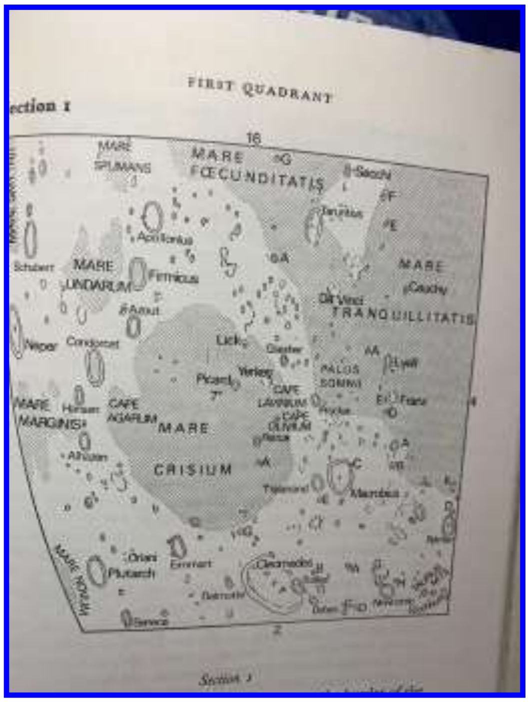


__Image 2__ Patrick Moore, New Guide to the Moon, 1976. Section one, Mare Crisium.

Through a very generous donation a couple of years ago, a fellow lunar observer sent to me some wonderful old lunar atlases. Looking at Mare Crisium through these atlases was a pleasure. The first atlas investigated was the <u>Lunar Crescent Sets</u> (image 3), Copyright 1957, Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. These large loose-leaf images were "Among the finest of all lunar photographs are those taken at Lick Observatory, University of California, by J. H. Moore and J. F. Chappell, with the great 36-inch refractor. They obtained the picture of the waxing Moon on June 2, 1938. The parts of the crescents … may be cut out and put together to form a mosaic in which the moon's diameter is about two feet". Image 4 is of Mare Crisium taken on that date, 84 years ago. Image 5 is a closer image of Mare Crisium on chart IX of this set, taken on a different, unspecified date.

***Image 3 Lunar Crescent Sets,** Copyright 1957, Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass.*

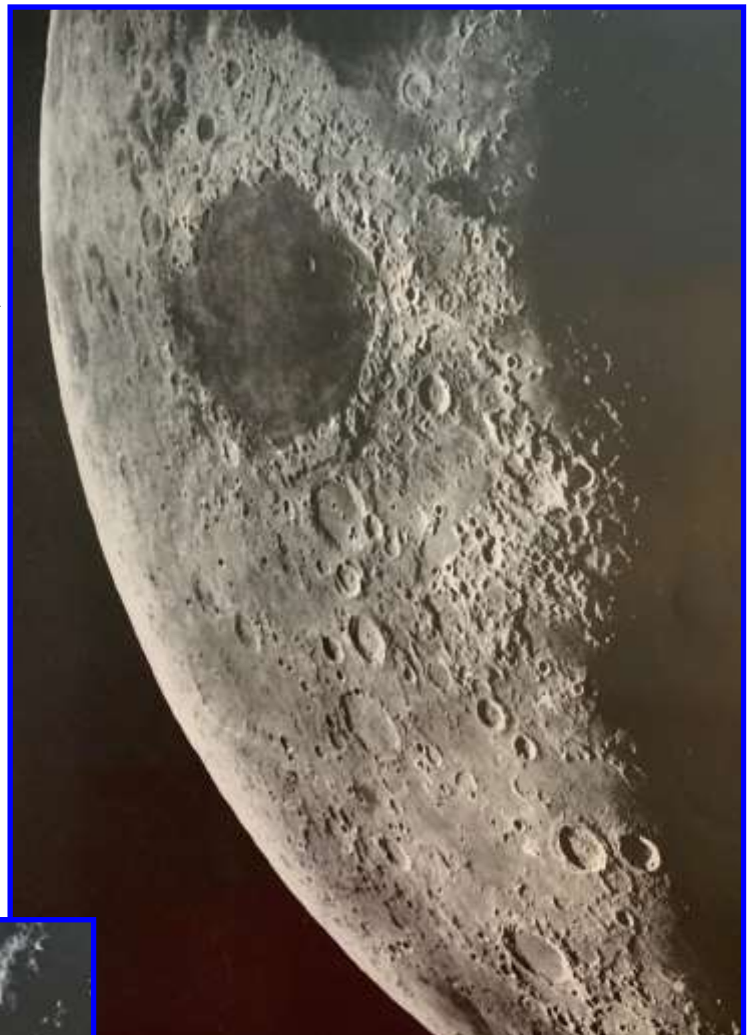
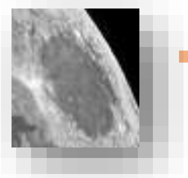
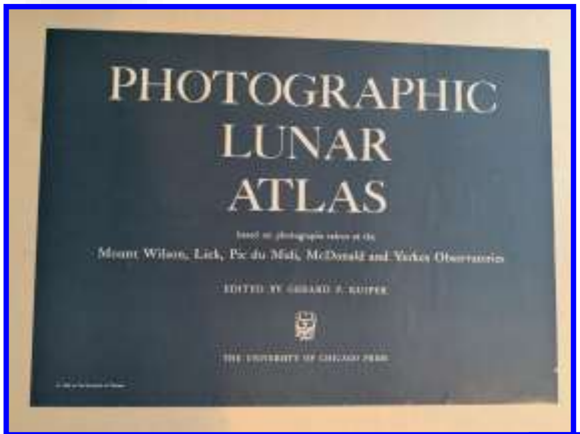


Image 4 Lunar Crescent Sets Plate 5, *Image taken at Lick Observatory on June 2, 1938. Copyright 1957, Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass.*

Image 5 Lunar Crescent, *Image taken at Lick Observatory. Copyright 1957, Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass.*





The next lunar atlas investigated for its view of Mare Crisium was the Photographic Atlas of the Moon, Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press. This was a large boxed set of loose-leaf lunar images (image 6). Please see images 7-14 for these images.

Image 6 Photographic Lunar Atlas, *Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

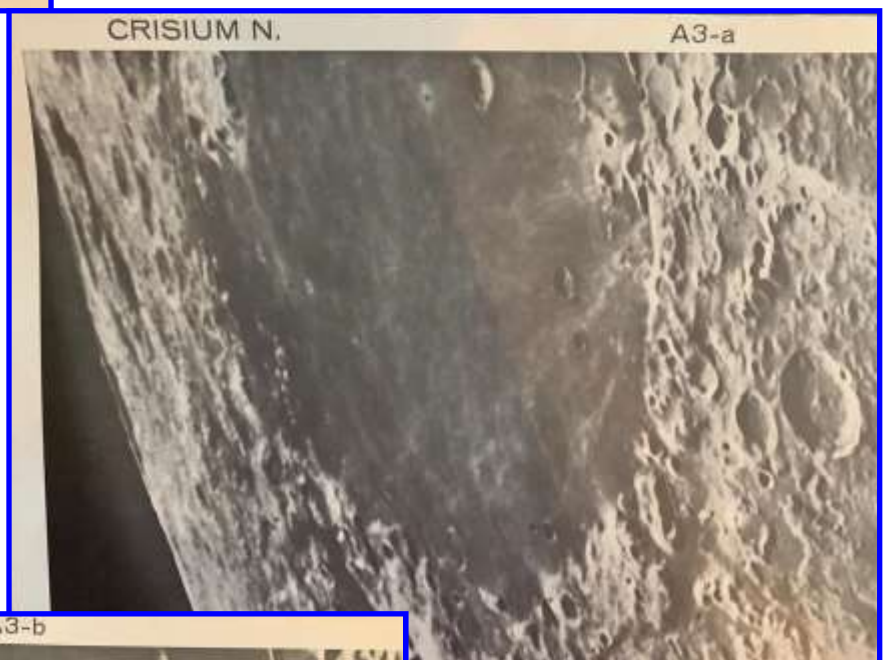


Image 7 Photographic Lunar Atlas, Crisium North, Plate A3-a. *Image taken at Yerkes Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

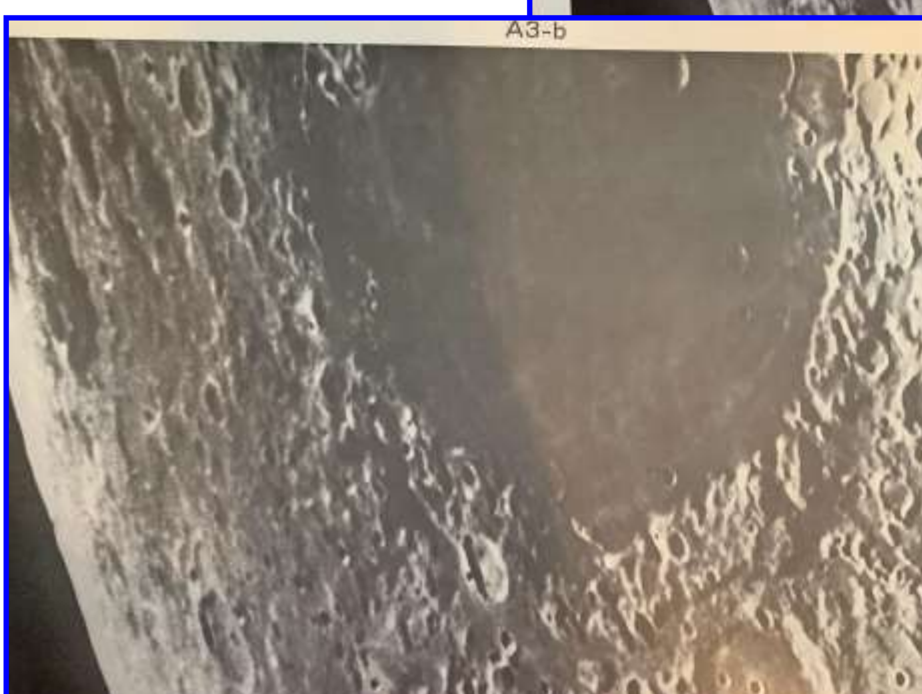


Image 8 Photographic Lunar Atlas, Crisium North, Plate A3-b. *Image taken at Lick Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

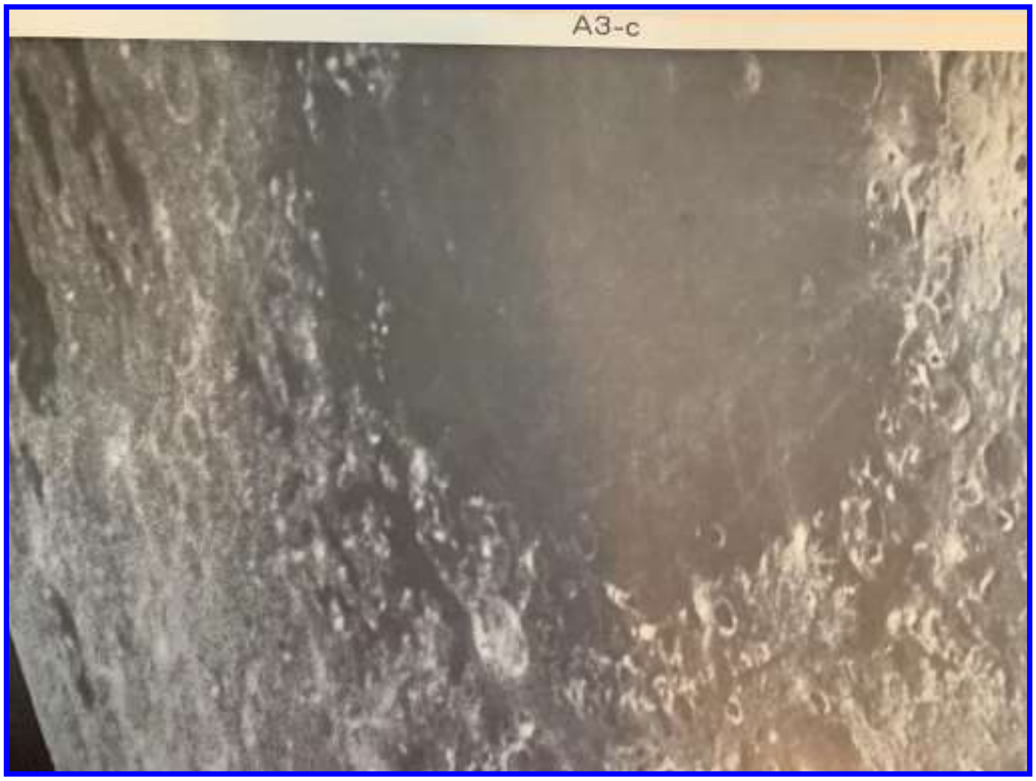


Image 9 Photographic Lunar Atlas, Crisium North, Plate A3-c. *Image taken at Lick Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

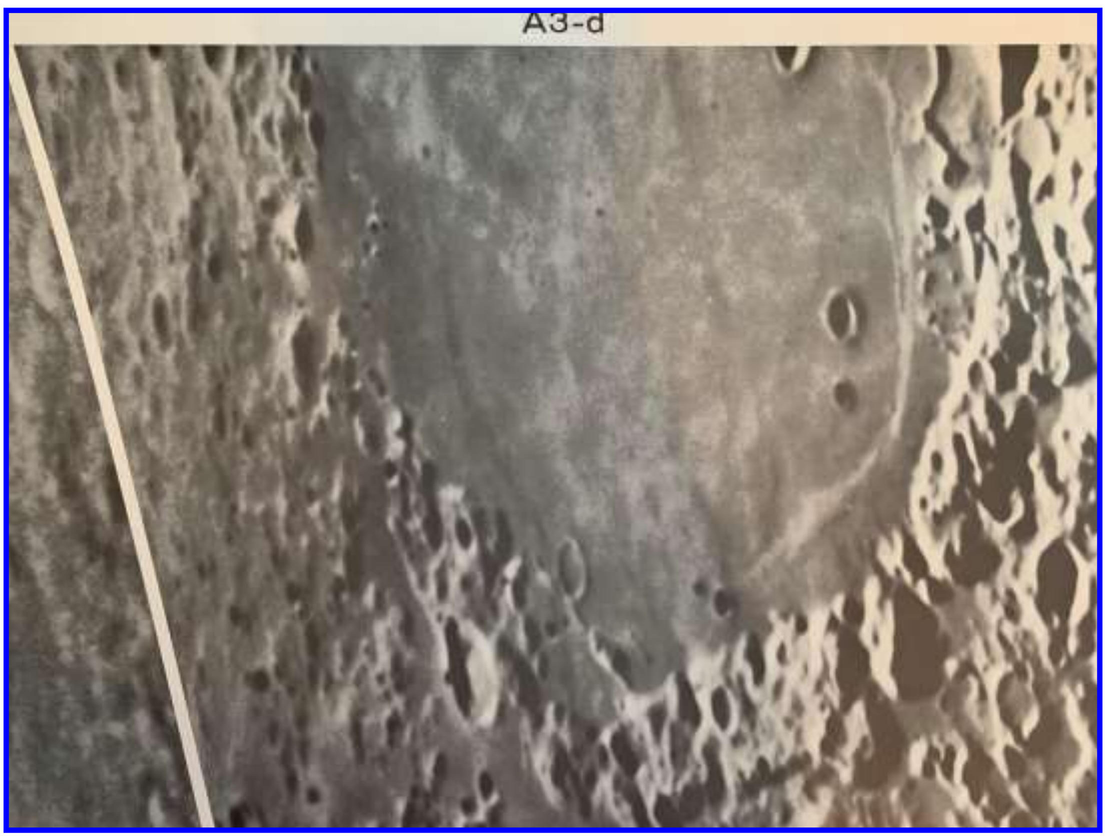


Image 10 Photographic Lunar Atlas, Crisium North, Plate A3-d. *Image taken at Lick Observatory, Pic du Midi Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

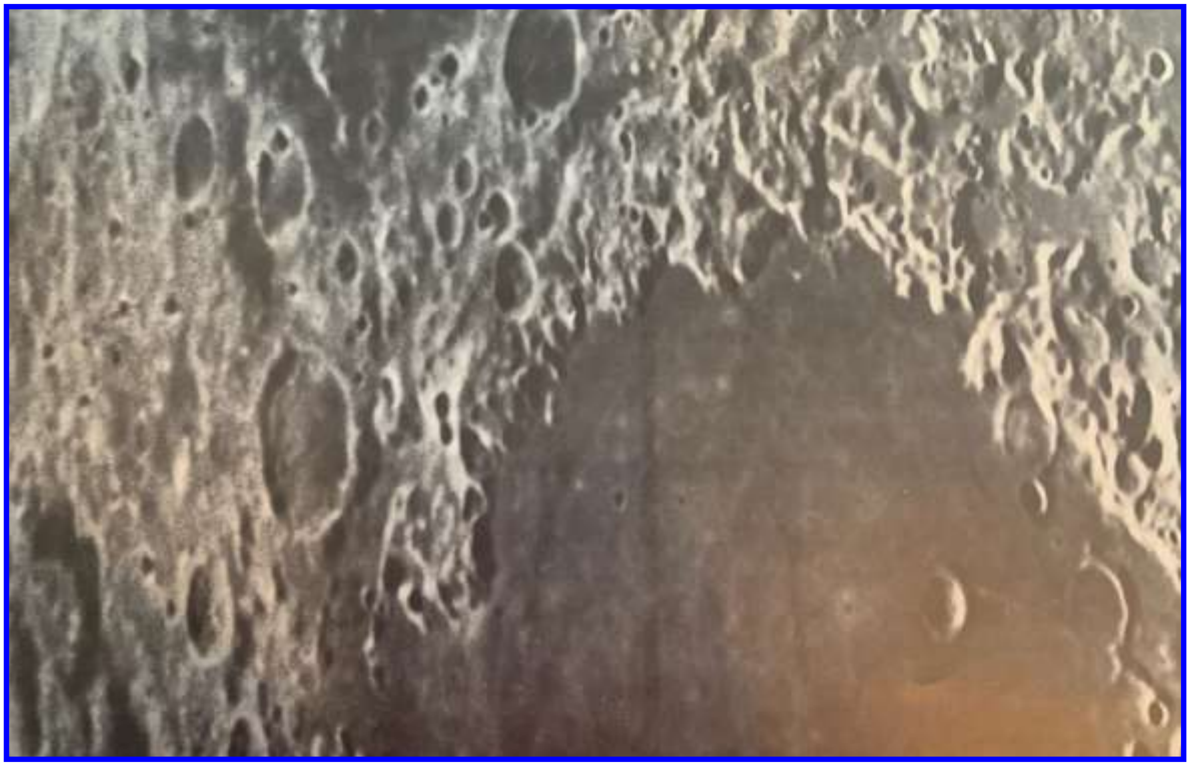


Image 11 Photographic Lunar Atlas, Crisium South, Plate A4-a. *Image taken at Lick Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

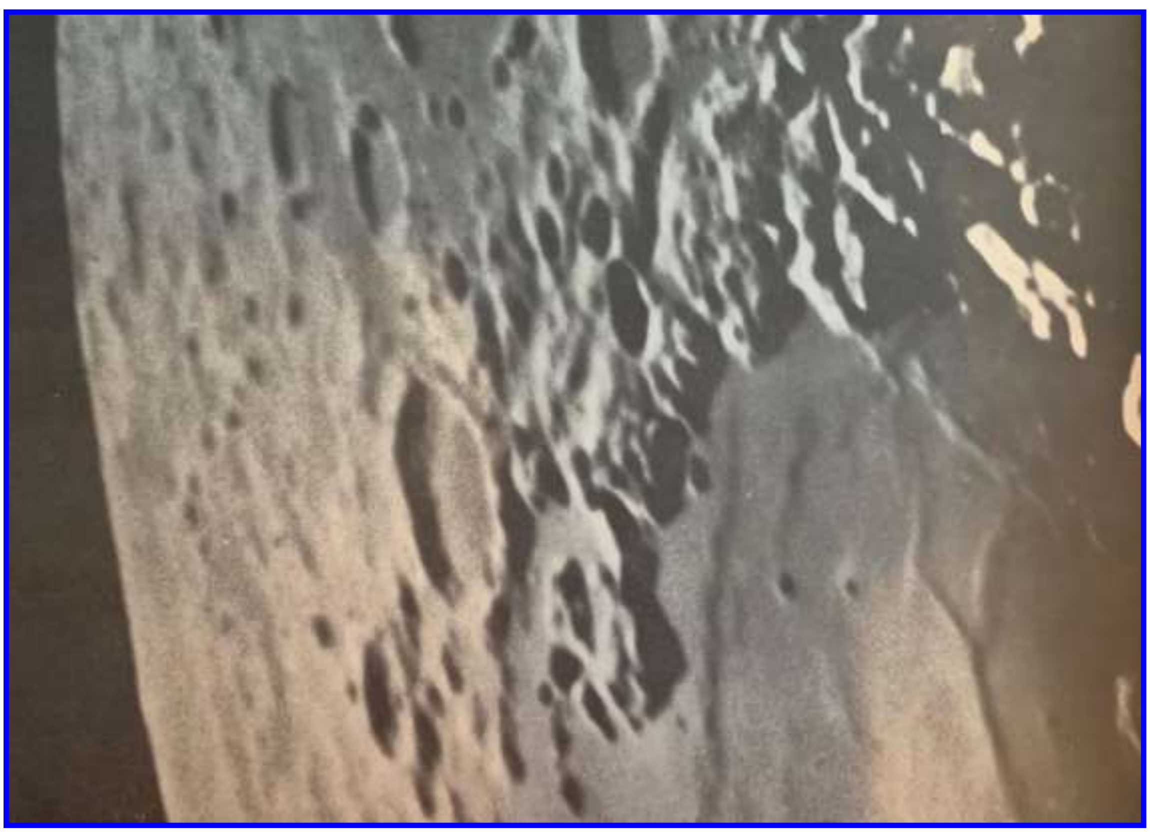


Image 12 Photographic Lunar Atlas, Crisium South, Plate A4-b. *Image taken at McDonald Observatory (?). Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

Image 13 Photographic Lunar Atlas, Crisium South, Plate A4-c. *Image taken at Lick Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

Image 14 Photographic Lunar Atlas, Crisium South, Plate A4-d. *Image taken at Yerkes Observatory. Mount Wilson, Pic du Midi, McDonald, Yerkes, Lick, Edited by Gerard P. Kuiper, University of Chicago Press 1960 University of Chicago Press.*

Another large, but this time bound lunar atlas was the Rectified Lunar Atlas, Supplement Number Two to the Photographic Lunar Atlas, E. A. Whitaker, G. P. Kuiper, W. K. Hartmann and L. H. Spradley, University of Arizona Press, Tucson 1963 (image 15). It shows Mare Crisium in chart 14-b, Image taken at Lick Observatory June 3, 1938 0400 UT as seen from above.

Image 15 Rectified Lunar Atlas chart 14-b. *Image taken Lick June 3, 1938 0400 UT. Supplement Number Two to the Photographic Lunar Atlas, E. A. Whitaker, G. P. Kuiper, W. K. Hartmann and L. H. Spradley, University of Arizona Press, Tucson 1963.*

The space race was in full force in 1963 when the Orthographic Atlas of the Moon, Supplement Number one, Part One (Central Area) to the USAF Lunar Atlas, published by Aeronautical Chart and Information Center, United States Air Force, Second and Arsenal Streets, St. Louis 18, Missouri. Compiled by D. W. G. Arthur and E. A. Whitaker, Edited by Gerard P. Kuiper was published. I enjoy the title of the United States Air Force Lunar Atlas. Here we see two images (images 16 and 17) of northern and southern Mare Crisium.

Image 16 Chart A3-a Crisium North. *Orthographic Atlas of the Moon, Supplement Number one, Part One (Central Area) to the USAF Lunar Atlas, published by Aeronautical Chart and Information Center, United States Air Force, Second and Arsenal Streets, St. Louis 18, Missouri. Compiled by D. W. G. Arthur and E. A. Whitaker, Edited by Gerard P. Kuiper.*

Image 17 Chart A4-a Crisium South. *Orthographic Atlas of the Moon, Supplement Number one, Part One (Central Area) to the USAF Lunar Atlas, published by Aeronautical Chart and Information Center, United States Air Force, Second and Arsenal Streets, St. Louis 18, Missouri. Compiled by D. W. G. Arthur and E. A. Whitaker, Edited by Gerard P. Kuiper.*

The Lunar Orbiter Photographic Atlas of the Moon by Bowker and Hughes, NASA 1971 gave us our first good in-orbit images of the Moon, including Mare Crisium (image 18).

Image 18 Lunar Orbiter Chart 331. *The Lunar Orbiter Photographic Atlas of the Moon by Bowker and Hughes, NASA 1971.*

A much more commonly available lunar atlas is The Hatfield Photographic Lunar Atlas edited by Jeremy Cook, 1999, Springer (image 19). Henry Hatfield took these excellent images of the Moon in the 1960s with his home-made 12-inch Newtonian. Attached is image 3a (image 20) from his atlas.

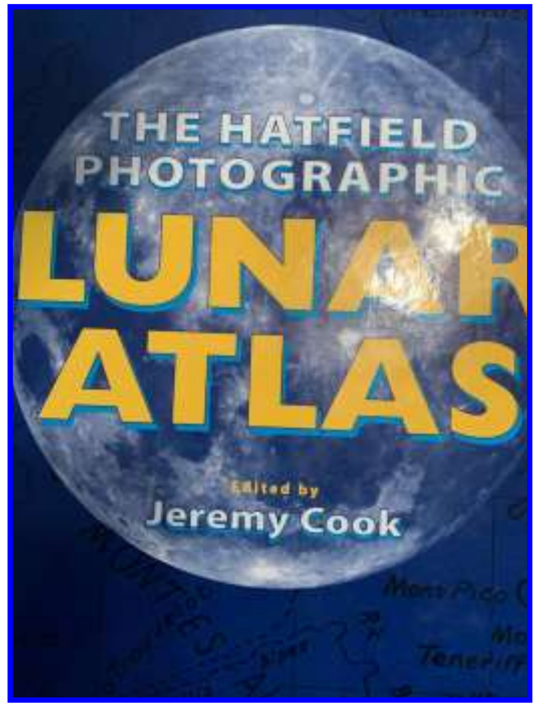
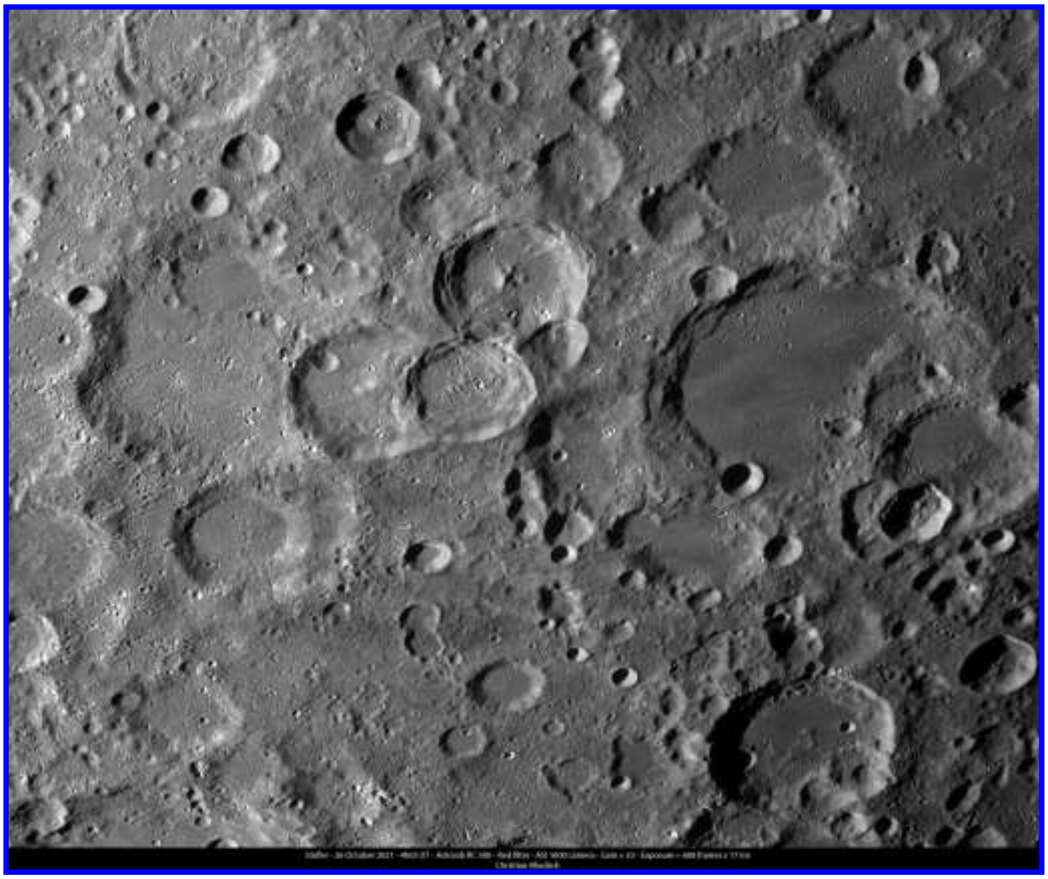


Image 19 *The Hatfield Photographic Lunar Atlas edited by Jeremy Cook. 1999, Springer.*

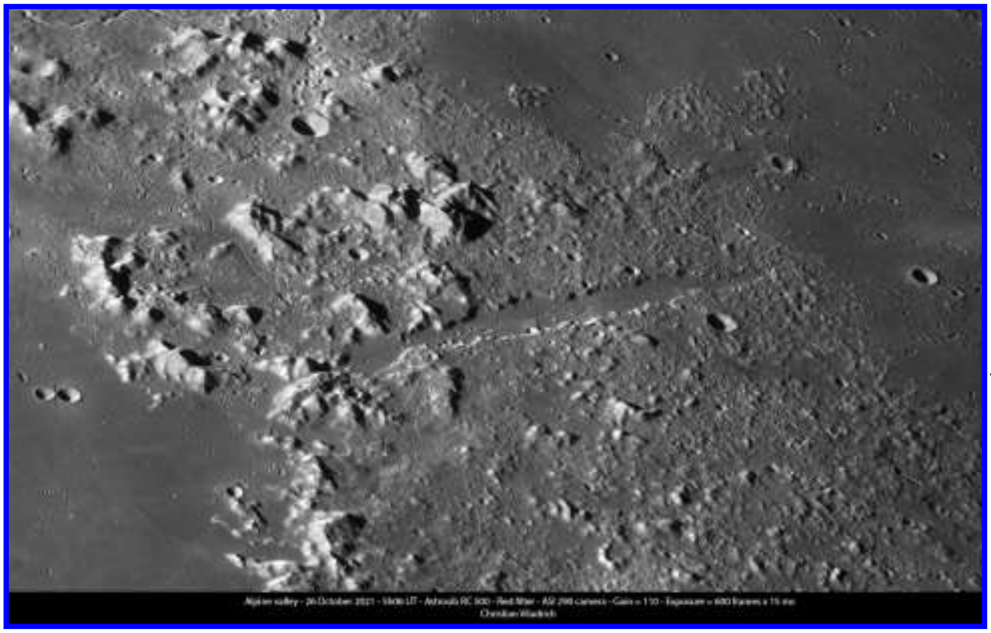
Image 20 Hatfield Chart 3a. *Image taken 1967 February 16 17:57 UT. Moon age 7.3 days. The Hatfield Photographic Lunar Atlas edited by Jeremy Cook. 1999, Springer.*

In the images above, all wonderful and mostly taken by professional astronomers with large professional telescopes (or even lunar orbit), it is interesting to compare these images to the images of Mare Crisium submitted by amateur astronomers of today. It is amazing how much modern digital cameras have improved the ability to gather data from celestial objects in a relatively short amount of time. I wonder how data will be collected 84 years from now?



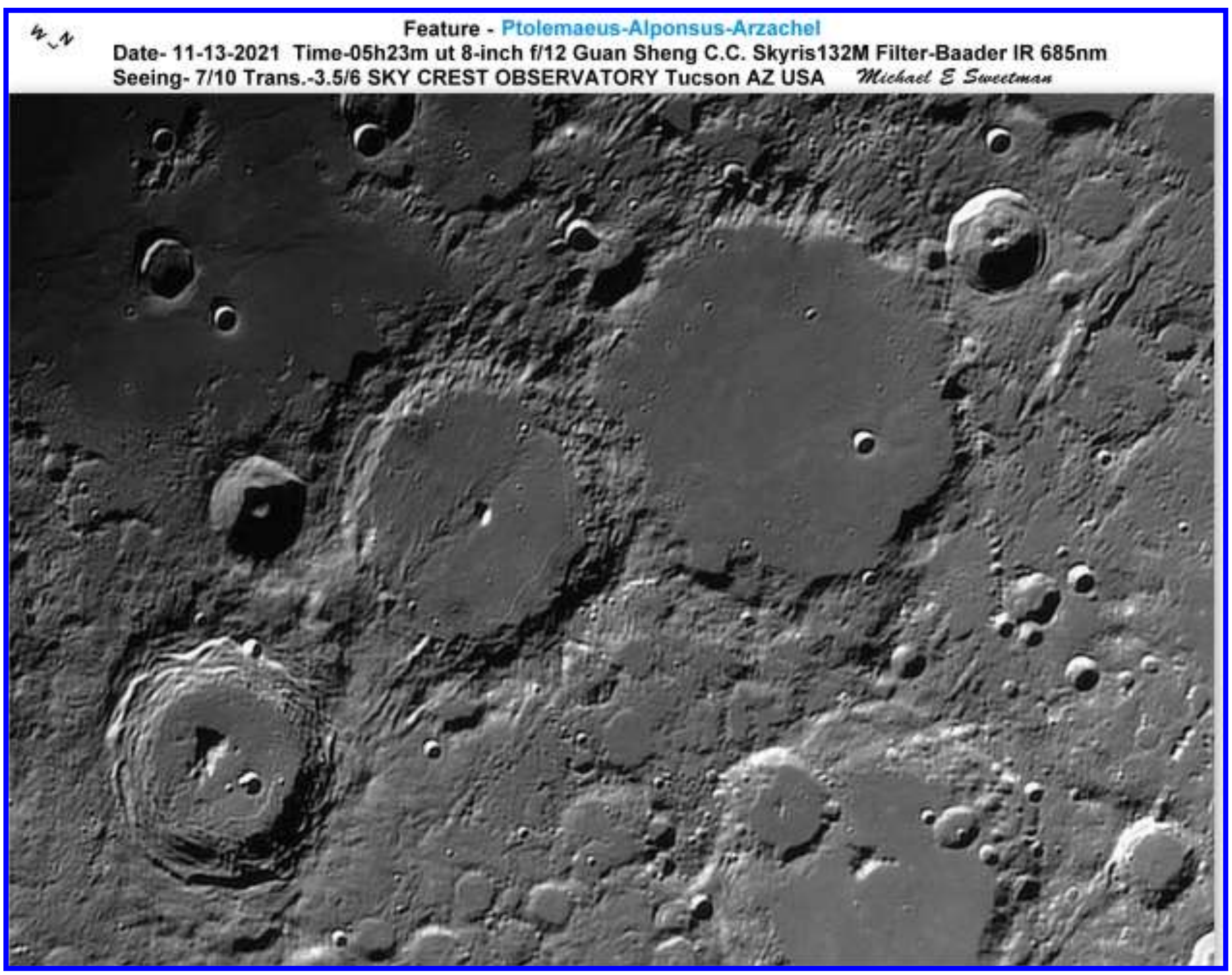
Stöfler, *Christian Viladrich, France. 2021 October 26 04:05 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Moon and Church Duomo of Milan, *Fabio Verza, SNdR, Milan, Italy. 2021 December 18 at 17:57 UT. Oppo A9 mobile phone.*



Alpine Valley, *Christian Viladrich, France. 2021 October 26 05:06 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Ptolemaeus, Alphonsus and Arzachel, *Michael Sweetman, SKY CREST OBSERVATORY, Tucson, Arizona, USA. 2-21 November 13 05:23 UT. 8 inch Guan Sheng Classical Cassegrain telescope, Baader 685 nm IR filter, SKYRIS 132M camera. Seeing 7/10, transparency 3.5/6.*

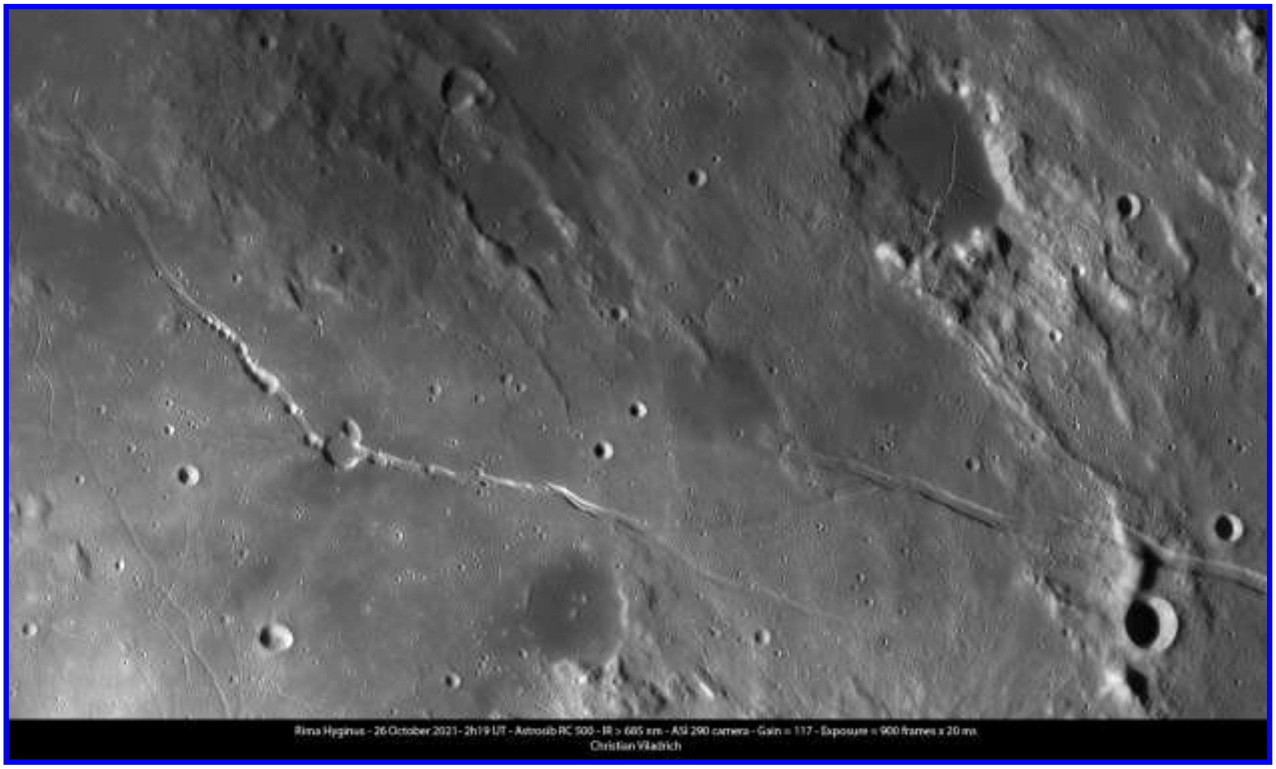


Rima Ariadaeus, *Christian Viladrich, France. 2021 October 26 01:30 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Alpes and Vallis Alpes, *Rafael Benavides Palencia, Cordoba, Spain. 2021 December 12 19:47 UT. Celestron 11 inch Schmidt-Cassegrain telescope, Baader IR pass filter, ZWO ASI290mm camera. Seeing 7/10, transparency 5/6.*

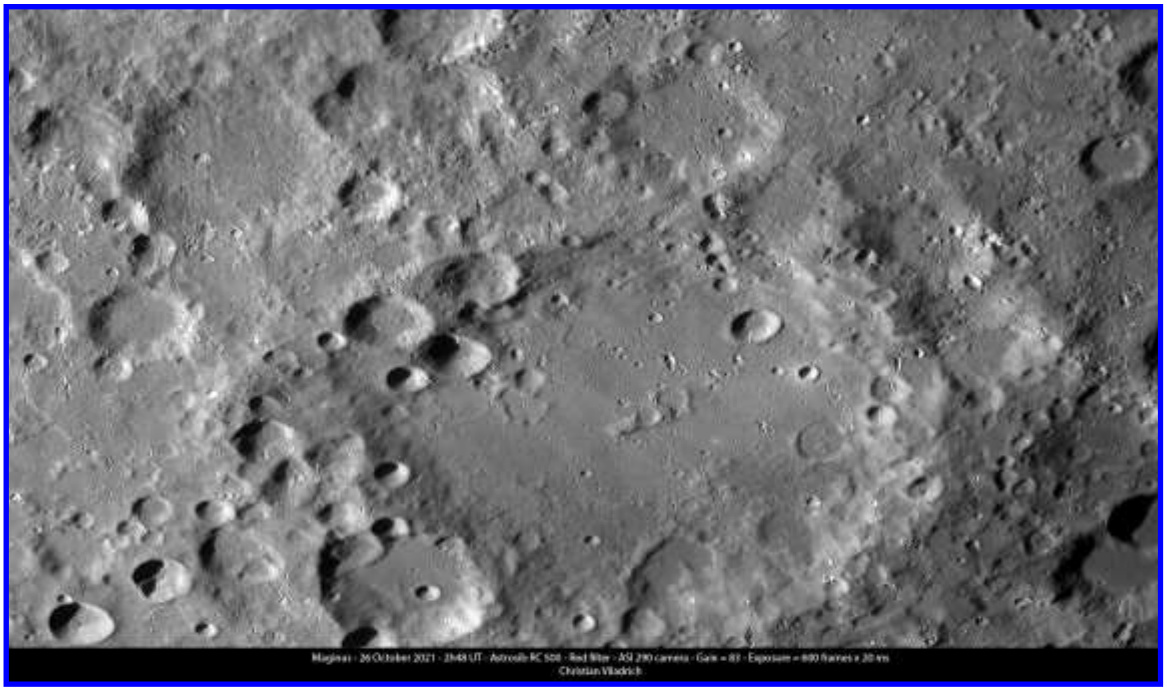
Clavius, *Christian Viladrich, France. 2021 October 26 01:02 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Waxing Gibbous Moon, *Jairo Chavez, Popayán, Colombia. 2021 December 17 23:49 UT. 311 mm truss Dobsonian reflector telescope, MOTO E5 PLAY camera.*



Hyginus, *Christian Viladrich, France. 2021 October 26 02:19 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

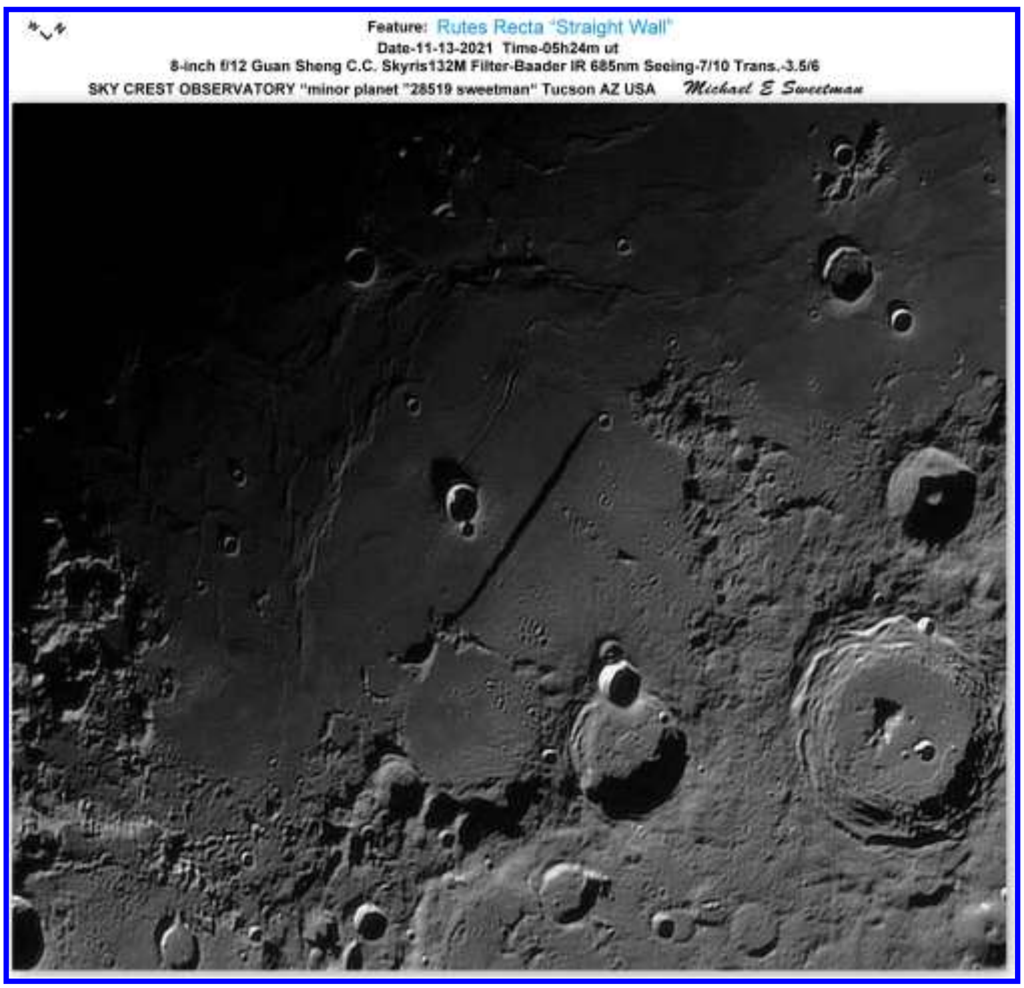
Lunar X, *Eduardo Horacek, Mar del Plata, Argentina. 2021 November 12 00:28 UT. 150 mm Maksutov-Cassegrain telescope, Canon EOS Rebel T5i camera. North lower right, west upper right.*



Maginus, *Christian Viladrich, France. 2021 October 26 02:48 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Moon and Venus Conjunction*, Leandro Sid, AEA, Oro Verde, Argentina. 2021 December 07 00:01 UT. Meade LightBridge Mini 82 mm reflector telescope and Meade StarNavigator NG 90 mm Maksutov-Cassegrain telescope, Motorola One Fusion cell phone camera.*

Plinius, *Christian Viladrich, France. 2021 October 26 01:48 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*



Rupes Recta, *Michael Sweetman, SKY CREST OBSERVATORY, Tucson, Arizona, USA. 2-21 November 13 05:24 UT. 8 inch Guan Sheng Classical Cassegrain telescope, Baader 685 nm IR filter, SKYRIS 132M camera. Seeing 7/10, transparency 3.5/6.*

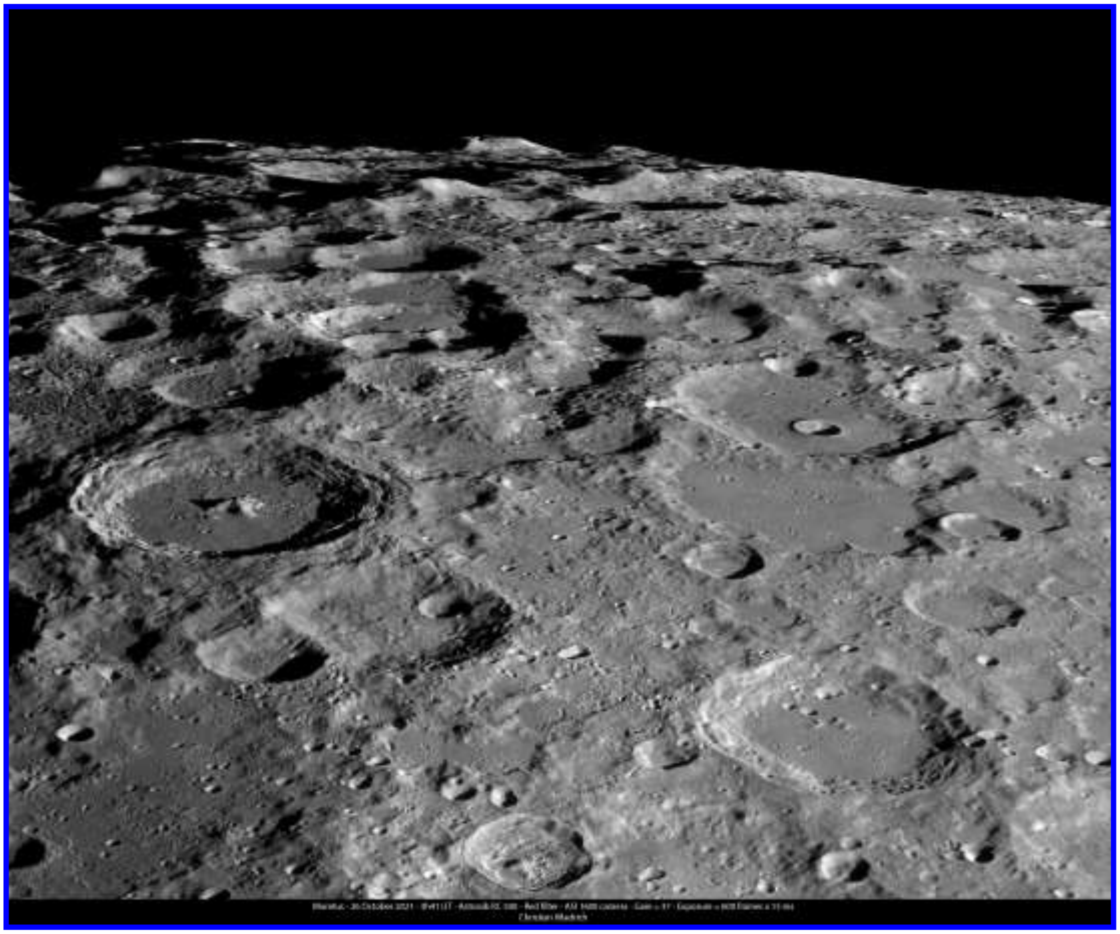
Stöfler, *Christian Viladrich, France. 2021 October 26 01:21 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Sinus Iridum, *Rafael Benavides Palencia, Cordoba, Spain. 2021 November 15 21:04 UT. Celestron 11 inch Schmidt -Cassegrain telescope, Baader IR pass filter, ZWO ASI290mm camera. Seeing 7/10, transparency 5/6.*

Moon and Venus Conjunction*, Leandro Sid, AEA, Oro Verde, Argentina. 2021 December 06 23:55 UT. Meade LightBridge Mini 82 mm reflector telesclope, Motorola One Fusion cell phone camera.*

Eudoxus, *Christian Viladrich, France. 2021 October 26 02:35 UT. Astrosib 500 mm Ritchey Chretien telescope, IR 685 nm filter, ZWO ASI290 camera.*

Moretus, *Christian Viladrich, France. 2021 October 26 03:41 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera. North down, west right.*



Moon and Church Duomo of Milan, *Fabio Verza, SNdR, Milan, Italy. 2021 December 18 at 17:52 UT. LG K50S mobile phone.*

Moon and Venus with Bell Tower, *Fabio Verza, SNdR. 2021 December 07 at 16:42 UT. Photo taken in Serina (BG), Italy, using a Oppo A9 mobile phone.*

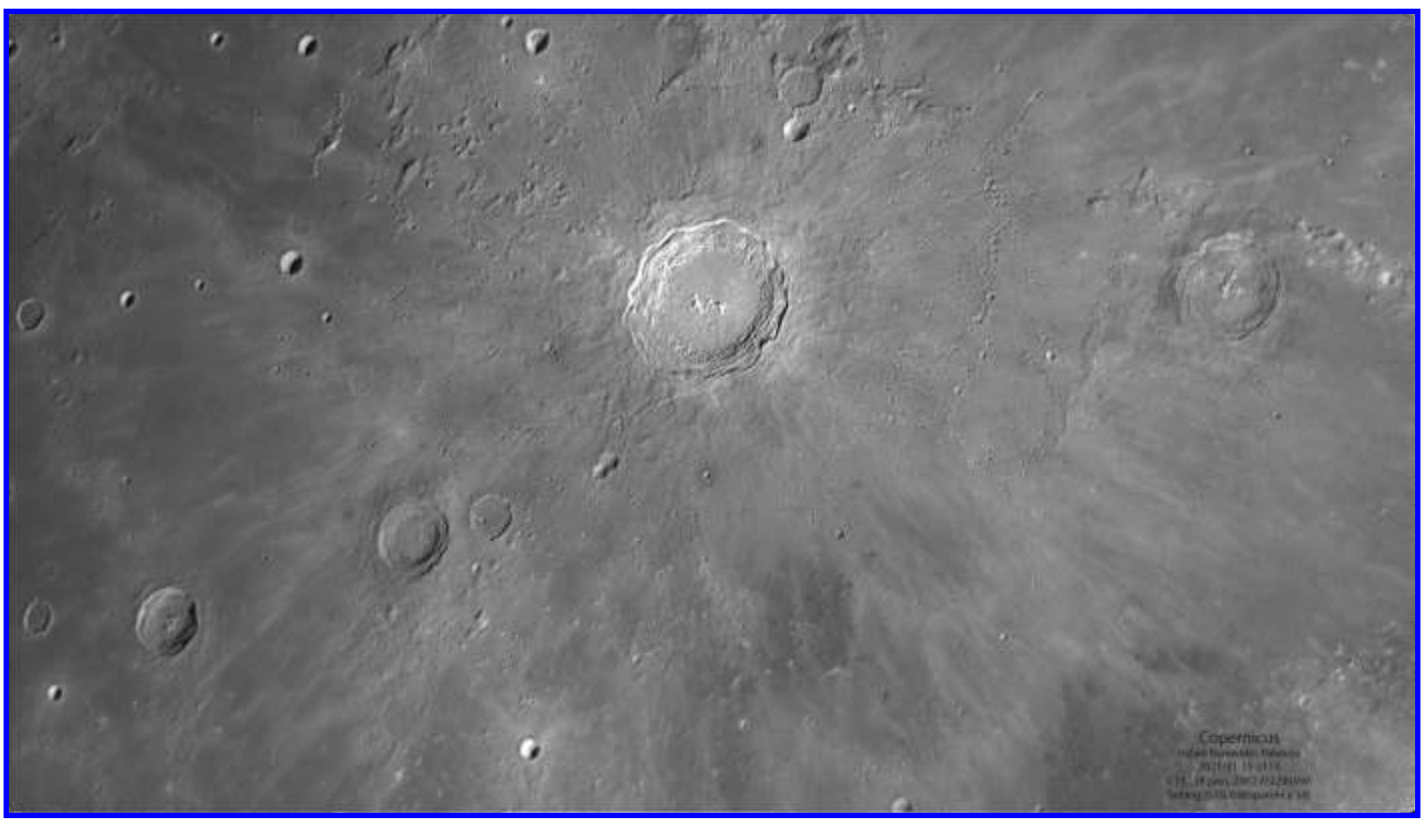
Aristoteles, *Christian Viladrich, France. 2021 October 26 02:31 UT. Astrosib 500 mm Ritchey Chretien telescope, IR 685 nm filter, ZWO ASI290 camera.*

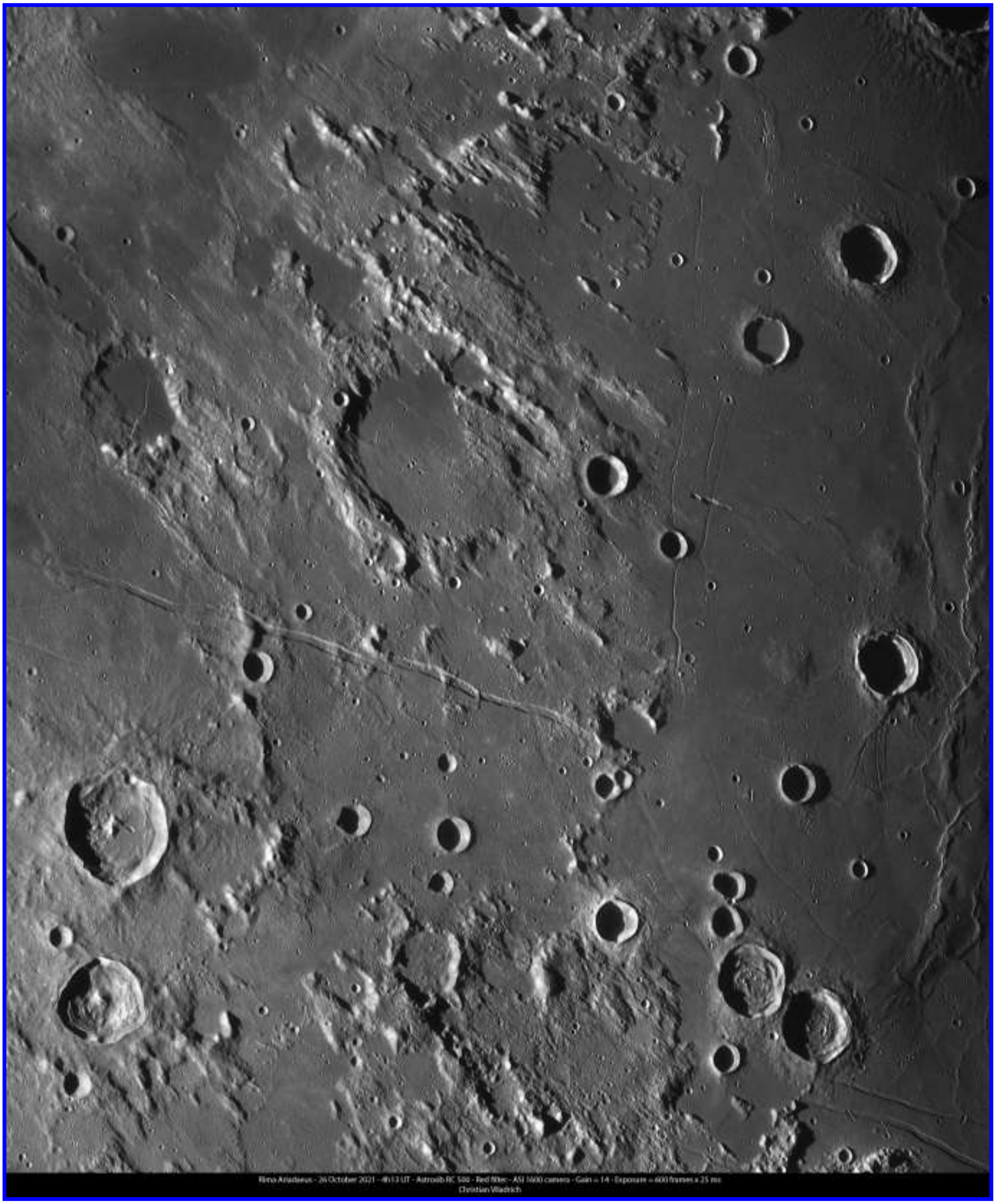
Moon and Venus with Christmas Tree, *Fabio Verza, SNdR. 2021 December 07 at 16:43 UT. Photo taken in Serina (BG), Italy, using a Oppo A9 mobile phone.*

Lacus Mortis, *Christian Viladrich, France. 2021 October 26 02:41 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

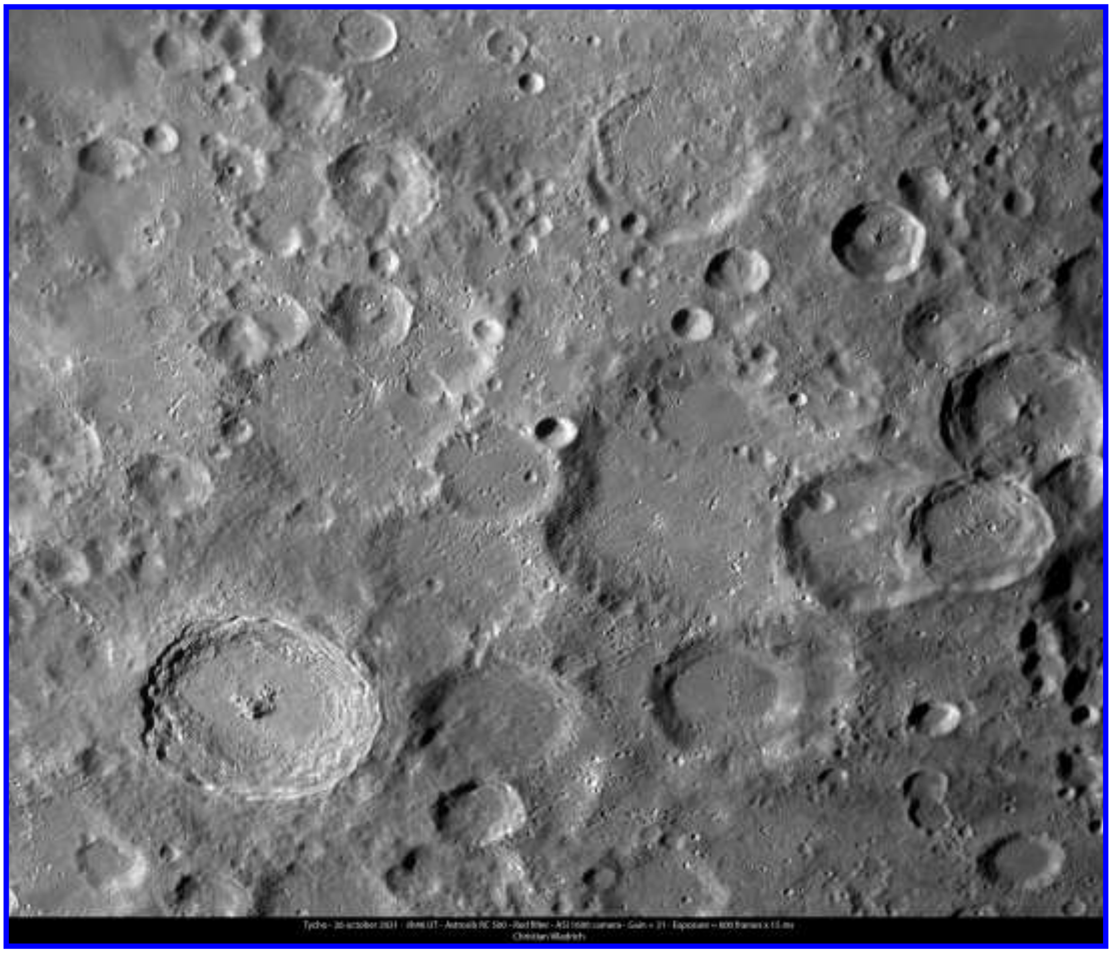
Eudoxus, *Christian Viladrich, France. 2021 October 26 04:29 UT. Astrosib 500 mm Ritchey Chretien telescope, IR 685 nm filter, ZWO ASI290 camera.*

Copernicus, *Rafael Benavides Palencia, Cordoba, Spain. 2021 November 15 21:14 UT. Celestron 11 inch Schmidt-Cassegrain telescope, Baader IR pass filter, ZWO ASI290mm camera. Seeing 7/10, transparency 5/6.*



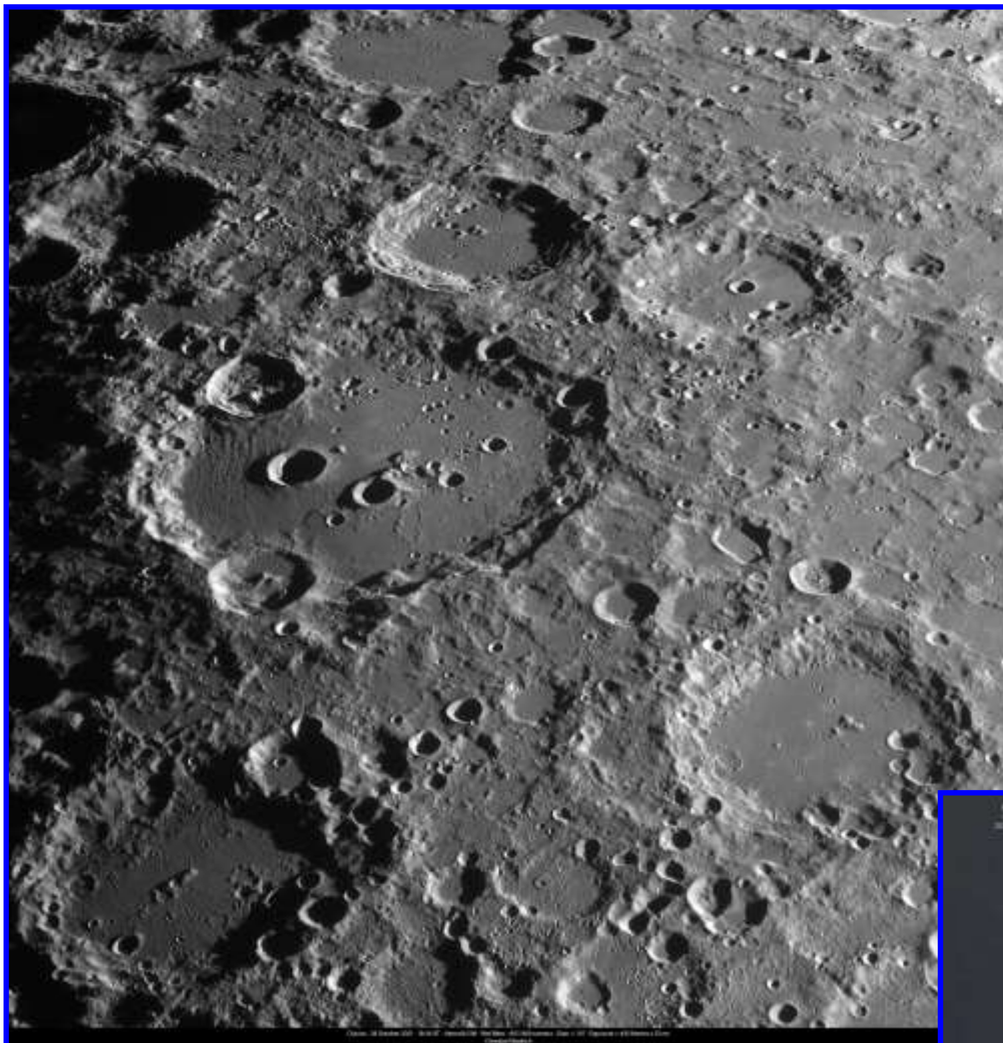


Ariadaeus, *Christian Viladrich, France. 2021 October 26 04:13 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*



Tycho, *Christian Viladrich, France. 2021 October 26 03:46 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera.*

Full Moon, *Jairo Chavez, Popayán, Colombia. 2021 December 19 02:12 UT. 311 mm truss Dobsonian reflector telescope, MOTO E5 PLAY camera. North right, west up.*



Clavius, *Christian Viladrich, France. 2021 October 28 03:36 UT. Astrosib 500 mm Ritchey Chretien telescope, red filter, ZWO ASI290 camera. North down, west right.*

Moon and Church Duomo of Milan, *Fabio Verza, SNdR, Milan, Italy. 2021 December 18 at 17:56 UT. LG K50S mobile phone.*

Lunar Geologic Change Detection Program

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

2022 January

Reports received for November included: Jay Albert (Lake Worth, FL, USA) observed: Archimedes, Aristarchus, Grimaldi, Langrenus, Mons La Hire, the lunar north polar region, Plato, Torricelli B and imaged several other features. Peter Anderson (Australia – BAA) imaged the lunar eclipse. Massimo Alessandro Bianchi (Italy – UAI) imaged: Rima Hadley. Rodrigo de Brix (Argentina – SLA) imaged: the lunar eclipse. Luis Francisco Alsina Cardinalli (Argentina – SLA) imaged: the lunar eclipse. Jorge Coghlan (Argentina – SLA) imaged: the lunar eclipse. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Arago, earthshine, the lunar eclipse, Theophilus, and the whole lunar disk. Walter Elias (Argentina – AEA) imaged: Alphonsus, Aristarchus, Atlas, Cleomedes, Dionysius, Endymion, Eratosthenes, Furnerius, Gassendi, Grimaldi, Harden, Langrenus, Mare Crisium, Mare Frigoris, Mare Tranquillitatis, Messier, Plato, Romer, Stofler, Tycho, and Vieta. Valerio Fontani (Italy – UAI) imaged: Aristarchus and Rima Hadley. Les Fry (West Wales – NAS) imaged: Cleomedes, Democritus, Endymion, Langrenus, Mare Crisium, Petavius, Taruntius, Vallis Rheita, Vendelinus, and Vlacq. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Albategnius, the lunar eclipse, and Ptolemeaus. Daniel Mendicini (Argentina – SLA) imaged: the lunar eclipse. Leandro Sid (Argentina – AEA) imaged: the Moon, Plato and Sinus Iridum. Trevor Smith (Codnor, UK – BAA) observed: several features including Censorinus and Proclus. Franco Taccogna (Italy – UAI) imaged: Tycho. Aldo Tonon (UAI) imaged: Rima Hadley.

TLP reports: No TLP reports have been received, since the last newsletter, though on 2021 Nov 20 UT 22:41-22:55 Trevor Smith (BAA) using a 16" reflector (Seeing: Antoniadi III-IV), found that there was a hint of red seen to the west of the ejecta field of Censorinus, but he comments that it was less noticeable than normal, perhaps because of the Moon's higher altitude that night. I guess that if one is going to see a hint of atmospheric spectral dispersion then it would be more noticeable on bright contrasty craters, such as Censorinus. He did not notice any atmospheric spectral dispersion elsewhere and no blue on the opposite side ejecta blanket, but that could be a contrast effect from Rayleigh scattering in our atmosphere at short optical wavelengths.

Routine Reports Received:

Helicon: On 2021 Nov 10 UT 00:34-00:37 Maurice Collins imaged the Moon under similar illumination and topographic libration (both to within ±1.0°) of the following report:

Helicon Bright spot seen. 1787 May 22 UT 21:00 (estimated) by M. de Villeneuvre. The Cameron 1978 catalog gives this TLP an ID No. of 36 and a weight of 1. The ALPO/BAA catalog weight is also 1.

Figure 1. *Part of a whole Moon image obtained by Maurice Collins (ALPO/BAA/RASNZ) on 2021 Nov 10 UT 00:34-00:37 and orientated with north towards the top.*

Although it is debatable whether Fig 1 reaches far enough west to cover the region on the Moon where Helicon would be, it emphasizes the fact that de Villeneuvre must have been observing this in earthshine. The 1887 May 22 TLP in the normally uninteresting crater Helicon (SE of Sinus Iridum), comes at a time when there was a spate of reports of lunar volcanos being seen in earthshine that year according to p64 of George G. Carey's book: "Astronomy, as it is Known at the Present Day: With an Account of the Nature…". The most notable of these was "Herschel's Volcano" on 19th April, though some regard that he may have mistaken Aristarchus, Copernicus and Kepler ray craters as volcanos – but the resemblance of the brighter one of these (Aristarchus?) *to "a small burning piece of charcoal, when it is covered by a thin coat of white ash"* has always puzzled me as Aristarchus generally does not exhibit color in earthshine. Anyway, whatever de Villeneuvre saw near Helicon, (technically speaking 3 minutes of arc from the edge of the Moon, towards the spot called Helicon) remains a mystery, though there is a bright small ray crater Laplace A that might show up in earthshine? Laplace A is only 8 km in diameter and fairly point-like so would appear at its brightest when seeing conditions were good. Helicon has featured in two other TLP reports: 1788 Mar 13 (earthshine) and 1979 Aug 7 (day side – but probably normal appearance).

Tycho: On 2021 Nov 14 Franco Taccogna (UAI) imaged this crater in red, green and blue filters under similar illumination to the following report:

Tycho 1998 Feb 06 UT 22:48-22:54 R. Braga (Corsica (MI), Italy, 102mm f8.8 refractor, x180, with diagonal, Wratten 23A, 80A and an OR5 filter, seeing II, Transparency good). Observer noticed that the floor darkened towards the NW (IAU), particularly with the blue Wratten 80A filter. The ALPO/BAA weight=2.

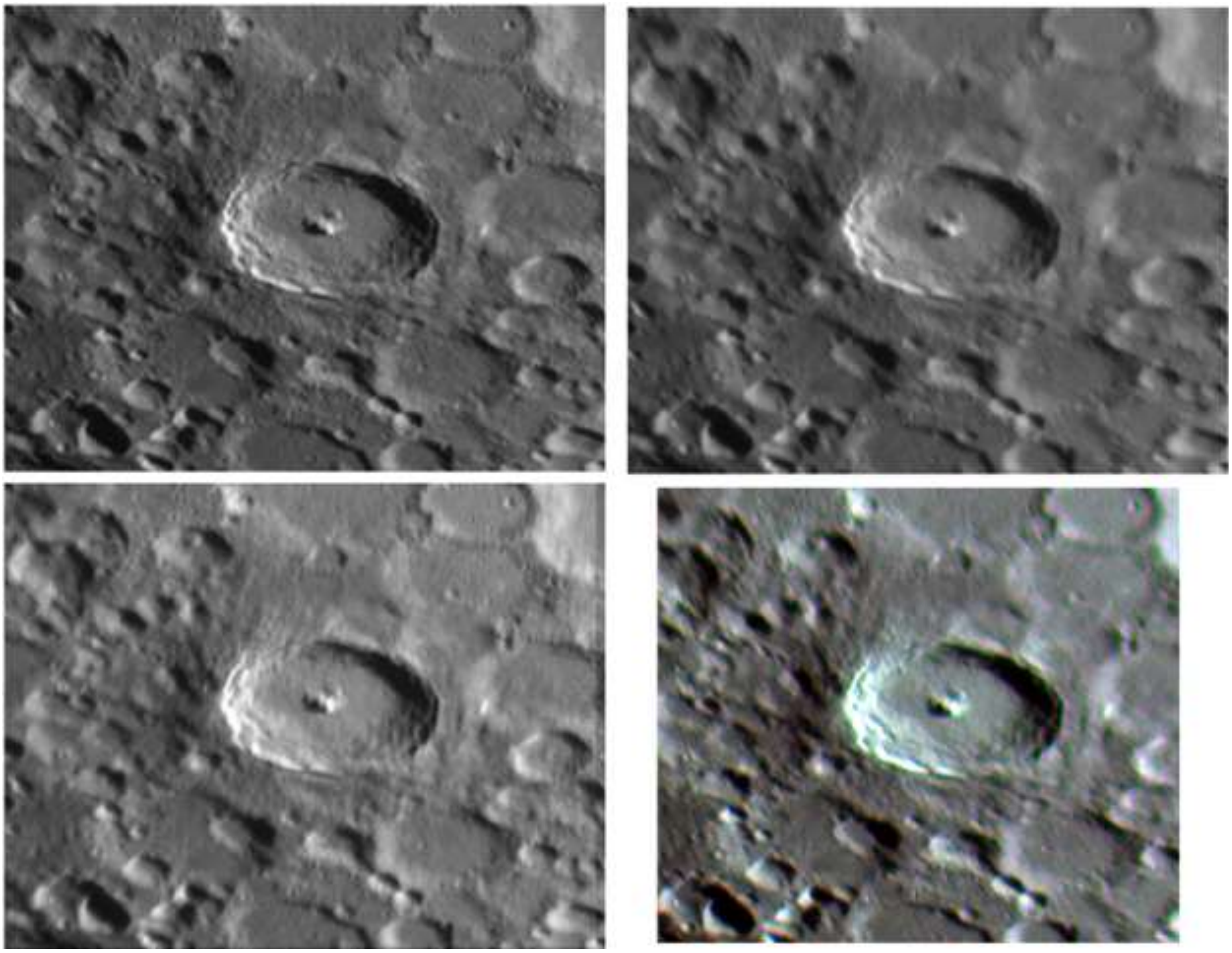


Figure 2. *Tycho as imaged by Franco Taccogna on 2021 Nov 20 and orientated with north towards the top.* ***(Top Left)*** *Red filter image captured at UT 16:53.* ***(Top Right)*** *Green filter image captured at UT 16:55.* ***(Bottom Left)*** *Blue filter image captured at UT 16:56.* ***(Bottom Right)*** *Combined RGB image that has been color normalized and then under gone a color saturation increase of 60%.*

Any color visible to human eyes should become very apparent on filter CCD images. The individual RGB images in Fig 2 (Top Left, Top Right, and Bottom Left) ought to show the NW corner of the floor brighter in the red and possibly green filters and/or darker in the blue filter. However, there is no sign of this. Even in a color enhanced version (Bottom Right) there is no obvious color on the NW floor. Therefore, whatever was seen back in 1998 was either lunar in origin or related to the local observing conditions/optics – however the use of filters should have precluded this possibility of it being due to atmospheric spectral dispersion or chromatic aberration. If you blur your eyes when looking at Fig 2, you may see a hint of darkening in the NW quadrant of the floor. We have examined repeat illumination observations of this TLP report before in the 2017 Nov (p26) and 2020 Dec newsletters. Back in 2017 Sep Jay Albert did detect some darkening on the NW floor in blue light visually, but this P59-60) was not confirmed by a camera phone image. On 2020 Oct 20 Daryl Dobbs observed a similar visual effect. I think we will lower the weight to 1 as something is triggering a visual perception of color on the NW quadrant, but so far nothing has been detected with color imagery.

Plato: On 2021 Nov 14/15 UT Leandro Sid and Walter Elias (AEA) imaged this crater under similar illumination to the following report:

Plato 1998 Mar 08 UT 19:30-20:10 S. Beaumont (Windermere, UK, 30cm reflector, Meade 23A and 38A filters, seeing III, transparency fairly good, some haze) observed a whitish misty effect seen bordering the shadows of the SE rim. It appeared intermittently and was not seen in the violet or red filters. Observer wonders if it could have been an effect associated with the Earth's atmosphere, which was unsteady with some haze. However, other craters appeared normal. The ALPO/BAA weight=1.

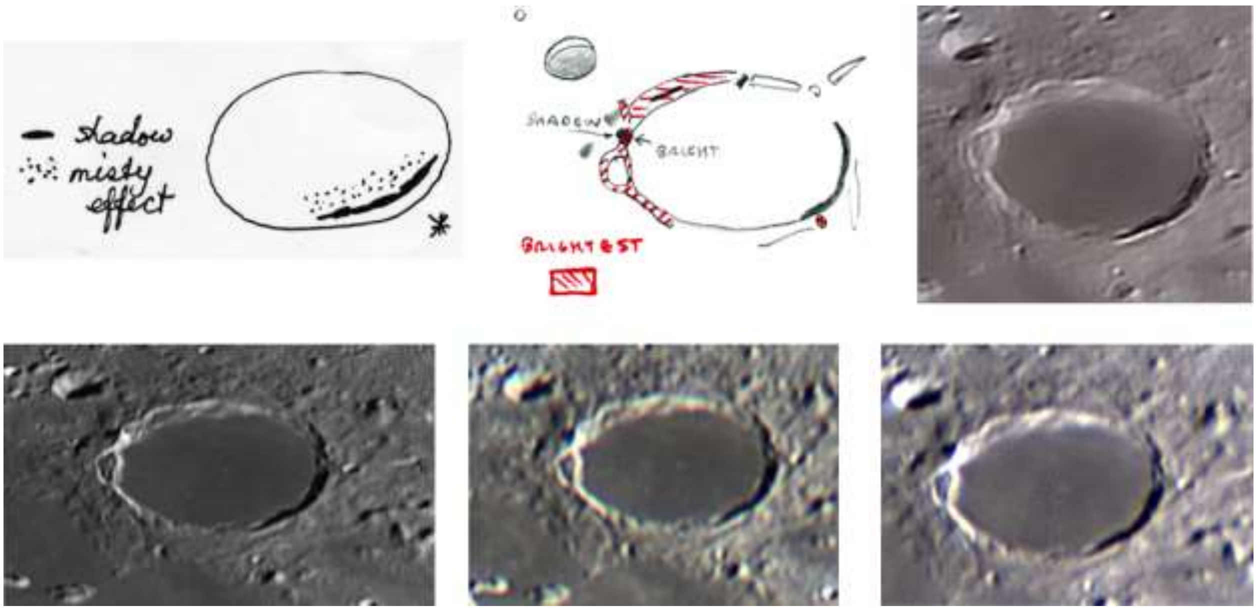


***Figure 3**. Plato, orientated with north towards the top. **(Top Left)** A sketch by Sally Beaumont (ALPO) made on 1998 Mar 08 UT 19:30-20:10. **(Top Center)** A sketch by Ron Livesey (BAA) made on 1998 Mar 08 UT 20:15 – note the red ink denotes the brightest parts of the crater and not color. "65 Spec", x133, seeing 3. Annotation has been rotated and moved. **(Top Right)** Image by Leandro Sid (AEA) taken on 2021 Nov 14 UT 23:52. **(Bottom Left)** An image by Franco Taccogna (UAI) taken on 2018 Jun 23 UT 21:39. **(Bottom Center)** A color image taken by Maurice Collins (ALPO/BAA/RASNZ) on 2018 Sep 20 UT 07:33. **(Bottom Right)** A image taken by Walter Elias (AEA) on 2021Nov 15 UT 00:58.*

It turns out that the Ron Livesey (BAA) was observing just 5 min after Sally finished her observation and saw nothing unusual. Compare Fig 3 (Top Left and Top Center). Leandro's image (Fig 3 – Top Right) also shows nothing unusual although pretty much all of the floor is featureless. Two of the lower images (Fig 3 Bottom Left, Bottom Center) are all from our archive and show an inner narrow white boundary between the SE shadow and the floor, under similarly the same illumination to Sally' sketch. A central craterlet us just visible as a light spot. Franco and Maurice's images though do have part of the lowest part of the crater rim making it into sunlight on the south east, possibly wall slump/inner terrace? Once we get to Walter's image (Fig 3 – Bottom Right) we see that the shadow has receded a bit further inside the SE rim and more of the inner terrace/wall slump is visible and begins to look a little like what Sally drew back in 1998. But then why did Ron not see a simar effect? Most likely because his scope was smaller and he was concentrating more on the brightest parts of the crater. I think we can now safely remove Salley's 1998 observation from the TLP database by assigning a weight of 0

Torricelli B: On 2021 Nov 16 UT 02:26-02:46 Jay Albert observed this crater under similar illumination to the following report:

Torricelli B 1995 Apr 11 UTC 20:15 Observed by North (UK). "Colour moon blink reaction, and crater dull". The Moon was at about 39° in altitude at the time. BAA Lunar Section report. ALP\BAA weight=3.

Jay used a Celestron NexStar Evolution 8" SCT, x226 an x290. His sky was partly cloudy and hazier than the previous night. Transparency was 1st magnitude and seeing was initially 7/10. The crater was dull, as described in the LTP listing. He compared the view in the Wratten 25 red and 44A blue filters with inconclusive results. However, as the haze increased, he thought the view in the red filter may have been a little enhanced compared with the blue.

We have received repeat illumination observations before i.e., in the 2019 Mar newsletter (p23-24), where Franco Taccogna (UAI) sent in some images. I showed these to Gerald North and he replied with the following back in 2019 Jan:

. . . . ."I observed between 19h 16m and 20h 55m UT using my 464 mm Newtonian reflector. I recorded the conditions as: " ANT. IV/V. Transparency poor, due to heavy haze and slight fog. At first, I thought that Torricelli B looked a little prominent in a low power (X104) eyepiece. That was the first night of using that particular eyepiece (a 25 Kellner, given to me with other parts of Bill Peter's telescope, by Bill's widow and son). Then I examined it at X144 and X207 (my 18mm and 12.5 mm Orthoscopic eyepieces and decided that Torricelli B was normal after all. Then I tried green and deep red colour filters. I found Torricelli B appeared very dull - in fact very hard to see - in the deep red filter. . . . . (But I am sure that I would not have suspected it as any genuine TLP, just an interesting effect).

The following night I found the same thing through the red and green filters. Normal through green, extremely dull through deep red. (Same telescope; ANT. V. Transparency fair).

My overall conclusion was that all was normal with Torricelli B (and everything else of the Moon) at the time of observation on 11th and 12th April 1995."

So, the dull nature is perfectly normal, and the fact that he saw the same effect the next night does imply it was not an LTP. Note that hazy conditions prevailed in both of the observations by Gerald and also the more recent one by Jay, though interestingly Jay found the crater a little "enhanced" in red light than in "blue" i.e., the opposite. I am interested in why people sometimes see colors, so will remove this from the TLP database, but will put it onto the Lunar Schedule web site with specific instructions not to observe unless there is haze present above the observing site.

Aristarchus: On 2021 Nov 17 Valerio Fontani (UAI) imaged this crater under similar illumination and topocentric libration (both within ±1.0°) to the following report:

Aristarchus 1975 May 23 P.W. Foley (Wilmington, UK, 12" reflector, x200, x360, x624, atmospheric clarity good, seeing III from 20:15-22:30, but then clouded out at 22:30, and from 23:15-01:15 seeing was IV-V with poor transparency) observed (22:20-20:45 UT) variation in the SE corner of the Aristarchus, namely the usual dark bands were alternating light to dark, not in keeping with other crater features. This effect was not linked to atmospheric turbulence. Also projected image of bands beyond the crater W. wall were repeatedly noted. The observer broke away from observing at 20:45UT to make a telephone alert call. At 20:55UT they noted that the area between Vallis Schroteri and Herodotus seemed very light/bright, also the E. exterior of the crater wall of Herodotus. From 21:01-21:11 A slight blueness was seen to extend from the NE corner of Aristarchus, along the exterior rim, across and beyond Herodotus to the SW. A thorough search was made of many bright areas, both near the terminator and to the E., but no blueness could be detected elsewhere. A slight orange hue was noted along the E. limb of the Moon (Spurious colour). From 21:18;22:30 Aristarchus seemed normal again, and likewise the head of Vallis Schroteri too. The observer was clouded out from 22:30-23:15 and from 23:15-01:30 the seeing was so appalling that no colour or projection of the bands could be seen. A Moon Blink was used during the session, but no colour was detected in this? Another observer, R.W. Rose (Devon, UK) observed 21:20-21:30 but had IV seeing, and saw nothing unusual, but commented that if TLP activity had been taking place, then they would probably not have seen it anyway. The ALPO/BAA weight=1.

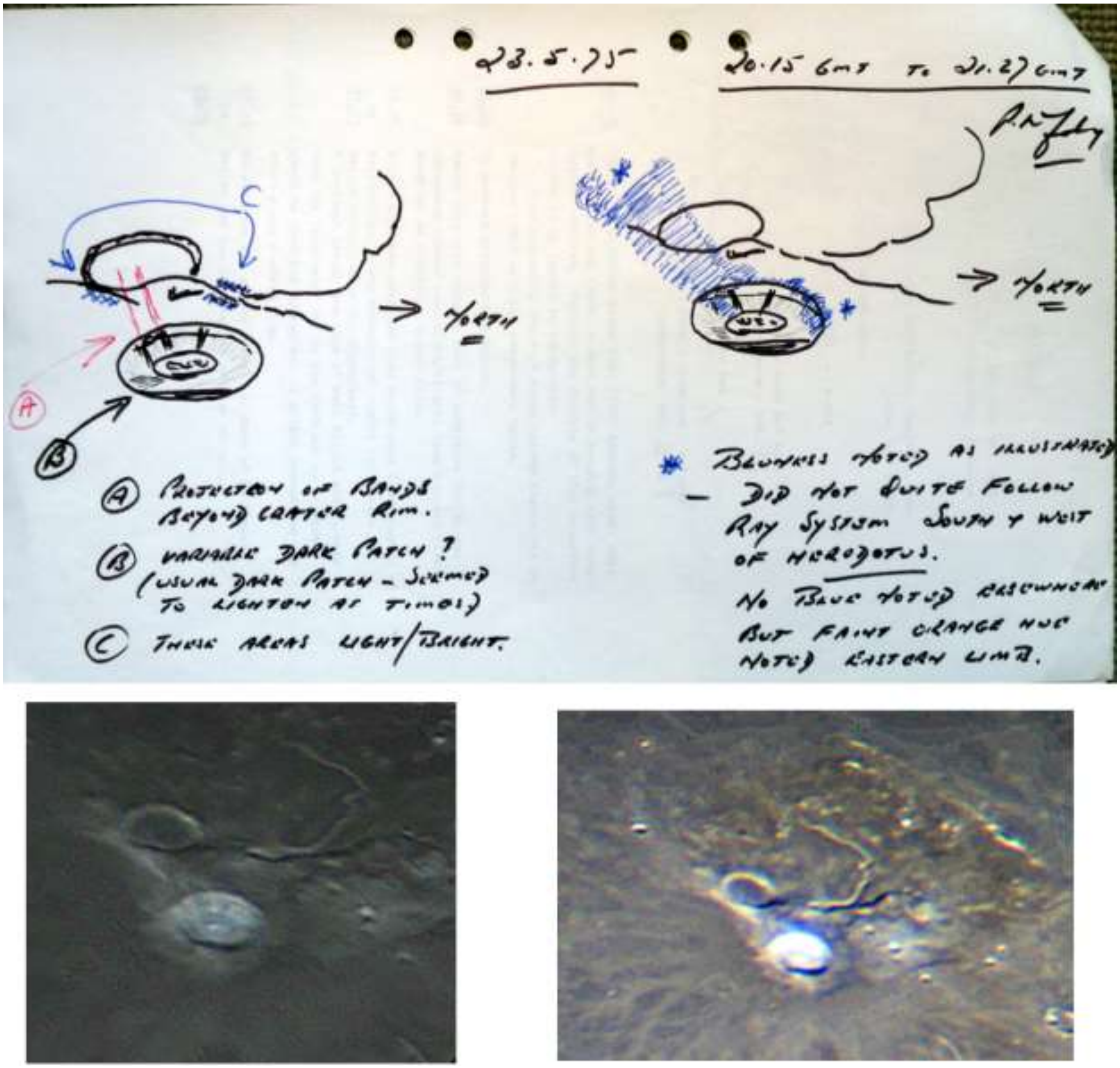


Figure 4. *Aristarchus orientated with north towards the right.* ***(Top)*** *A couple of sketches made by Peter Foley form 1975 for the date and UT range given at the top of the page.* ***(Bottom Left)*** *A color image by Valerio Fontani taken on 2021 Nov 17 UT 18:58. The color saturation has been increased to 70%.* ***(Bottom Right)*** *A color image by Maurice Collins taken on 2015 Jul 29 UT UT08:38-08:29 with color saturation increased to 60%.*

Valerio Fontani's image (Fig 4 – Bottom Left) is unique in that it is what Aristarchus would have normally looked like on the night that Peter Foley observed to within ±1.0° similar illumination and also topocentric libration (viewing angle). The image is slightly under exposed, but clearly shows what Foley refers to as an extension of the SW interior dark bands of Aristarchus, beyond the rim and out onto the out-side – see "A" in Fig 4 (Top). Likewise, what Foley marks as "C" or light/bright areas are visible too. Peter Foley's "B" area is a mixture of detail in Valerio's image, so is not surprising it will vary under poor seeing conditions. As to the blueness depicted in Fig 4 (Top) sketches, we can see some of this around the north rim of the crater in Maurice Collins similar illumination sketch (Fig 4 – Bottom Right). What is puzzling though is the large area of blueness that Foley draws over the ray and beyond its boundary. I think we need to leave the weight at 1 for now but refocus the description onto the extent of the blueness seen.

Partial Lunar Eclipse – 2021 Nov 21: Images were received from: SLA observers: Rodrigo de Brix, Luis Francisco Alsina Cardinalli, Jorge Coghlan, Daniel Mendicini, Peter Anderson (BAA), Maurice Collins (ALPO/BAA/RASNZ) and Rik Hill (ALPO/BAA). As eclipse go this was nearly, but not quite total, and observing conditions were not great for most observers.

SLA observers, operating from Sante Fe, Argentina, secured pre-eclipse images prior to first contact of the Penumbra at 06:02, which are effectively images of the Full Moon. This is useful for our project to study the relative brightness of features around Full Moon time. Measurements of digital number brightness sorted from dark to bright were found to be:

Plato (144), Kepler (186), Copernicus (198), Aristarchus (129), Tycho (129), Censorinus (216), Proclus (222) and the bright patch near Hell (225).

A slightly unusual appearance was seen on the edge of the shadow in an image (Fig 5) by Maurice Collins which looks like a nick in the edge of the umbra, but it is only the high albedo crater Aristarchus emerging from the shadow and the contrast stretched image makes it look like an indent.

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Figure 5. *The partial lunar eclipse of 2021 Nov 19 UT 09:51 taken by Maurice Collins (ALPO/BAA/RASNZ) and orientated with north towards the top. Note the nick in the shadow edge effect due to Aristarchus.*

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: http://users.aber.ac.uk/atc/lunar_schedule.htm . By re-observing and submitting your observations, only this way can we fully resolve past observational puzzles. To keep yourself busy on cloudy nights, why not try "Spot the Difference" between spacecraft imagery taken on different dates? This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP 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 TLP 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

Lunar Calendar January 2022

Date	UT	Event
1	2300	Moon at perigee 358033 km large tides
2	1833	New Moon, lunation 1225
2		Greatest southern declination –26.1°
4	1700	Saturn 4° north of Moon
6		North limb most exposed +6.7°
6	0000	Jupiter 4° north of Moon
8		East limb most exposed +7.6°
9	1811	First Quarter Moon
13	0000	Ceres 1.2° south of Moon, occultation western Canada, Alaska, Russia
14	0900	Moon at apogee 405805 km
15	2100	Moon 1.8° north of M35
16		Greatest northern declination +26.2°
17	2348	Full Moon, smallest of 2022
21		South limb most exposed -6.6°
23		West limb most exposed -6.0°
25	1341	Last Quarter Moon
29	1500	Mars 2° north of Moon
30	0700	Moon at perigee 362252 km
30		Greatest southern declination -26.4°

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

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

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

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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: Stevinus and Furnerius

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 March 2022 Focus-On will be the craters Stevinus and Furnerius. Observations at all phases and of all kinds (electronic or film based images, drawings, etc.) are welcomed and invited. Keep in mind that observations do not have to be recent ones, so search your files and/or add these features to your observing list and send your favorites to (both):
Alberto Anunziato – albertoanziato@yahoo.com-ar
David Teske – david.teske@alpo-astronomy.org

Deadline for inclusion in the Stevinus and Furnerius Focus-On article is February 20, 2022

FUTURE FOCUS ON ARTICLES:

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

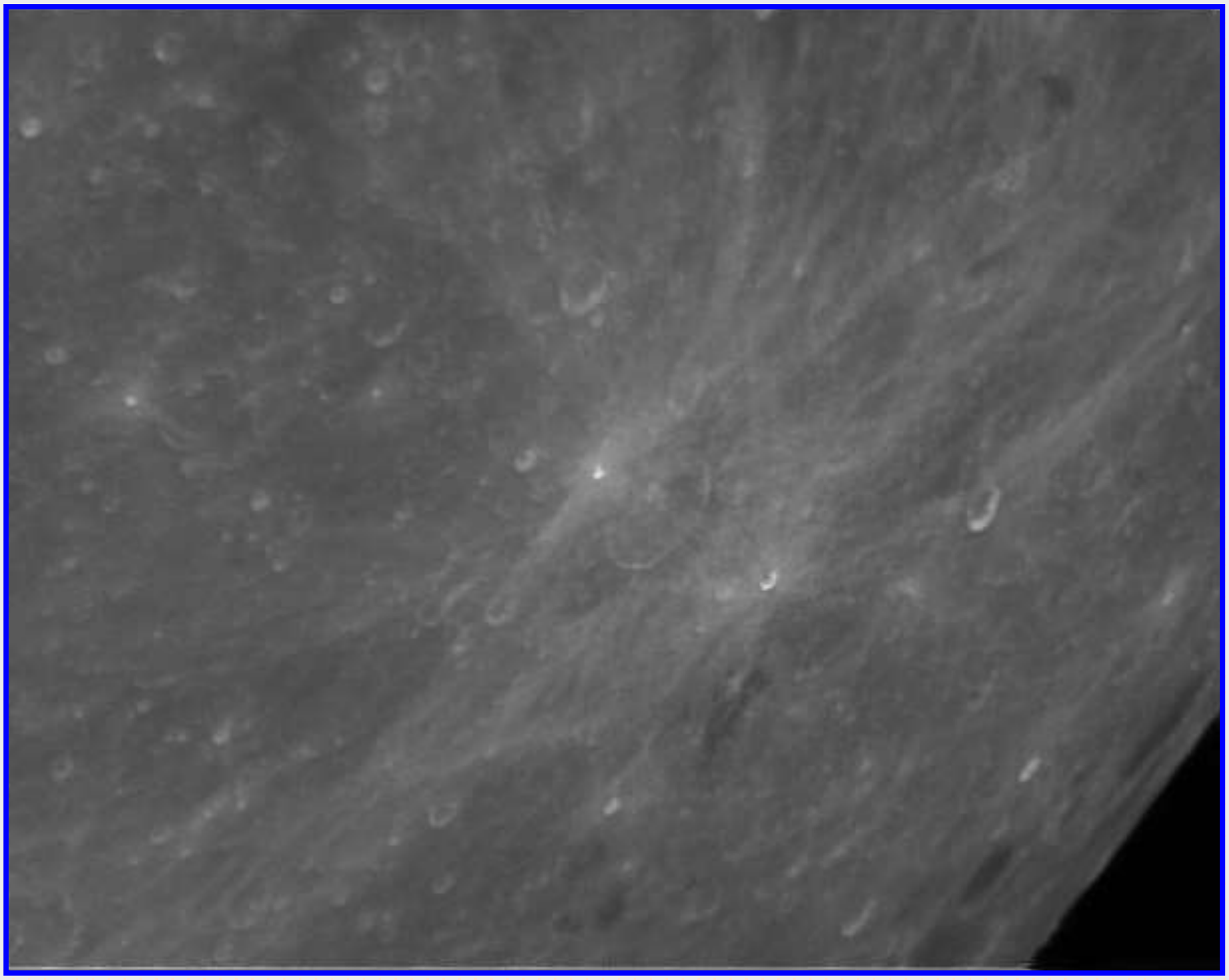
Subject	TLO Issue	Deadline
Stevinus and Furnerius	**March 2022**	**February 20, 2022**
Mare Frigoris	**May 2022**	**April 20, 2022**

Focus-On Announcement

THE TWO FACES OF STEVINUS AND SNELLIUS

Stevinus and Snellius are two craters of almost identical size (75 and 83 km in diameter) located in the southeast quadrant of the Moon. They are two very different brothers: the Copernican Stevinus has the characteristics of a "young" crater, such as a central peak and terraced walls, while the Nectarian Snellius is the typical crater degraded by billions of years of successive meteoric impacts. The region is best known for the "headlights of the Moon", the Stevinus A and Furnerius A craters, which flank Stevinus and are two of the brightest ray systems on the lunar surface. It's amazing how two small craters can shine so brightly. But for this you have to wait for the full moon. The area is a delight to watch at any phase.

Please send articles, drawings, images, etc. to Alberto Anunziato and David Teske by **February 20, 2022** for the March 2022 issue of The Lunar Observer.

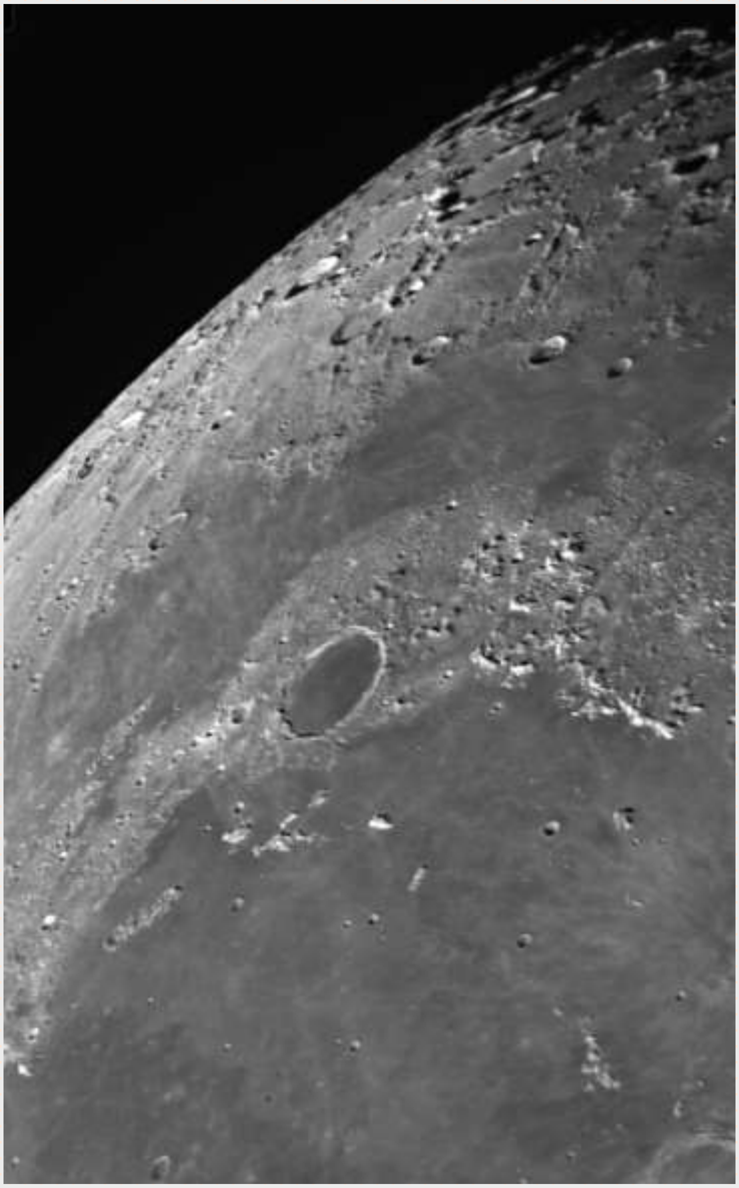


Focus-On Announcement

TRAVELING FROM EAST TO WEST ON THE MARE FRIGORIS

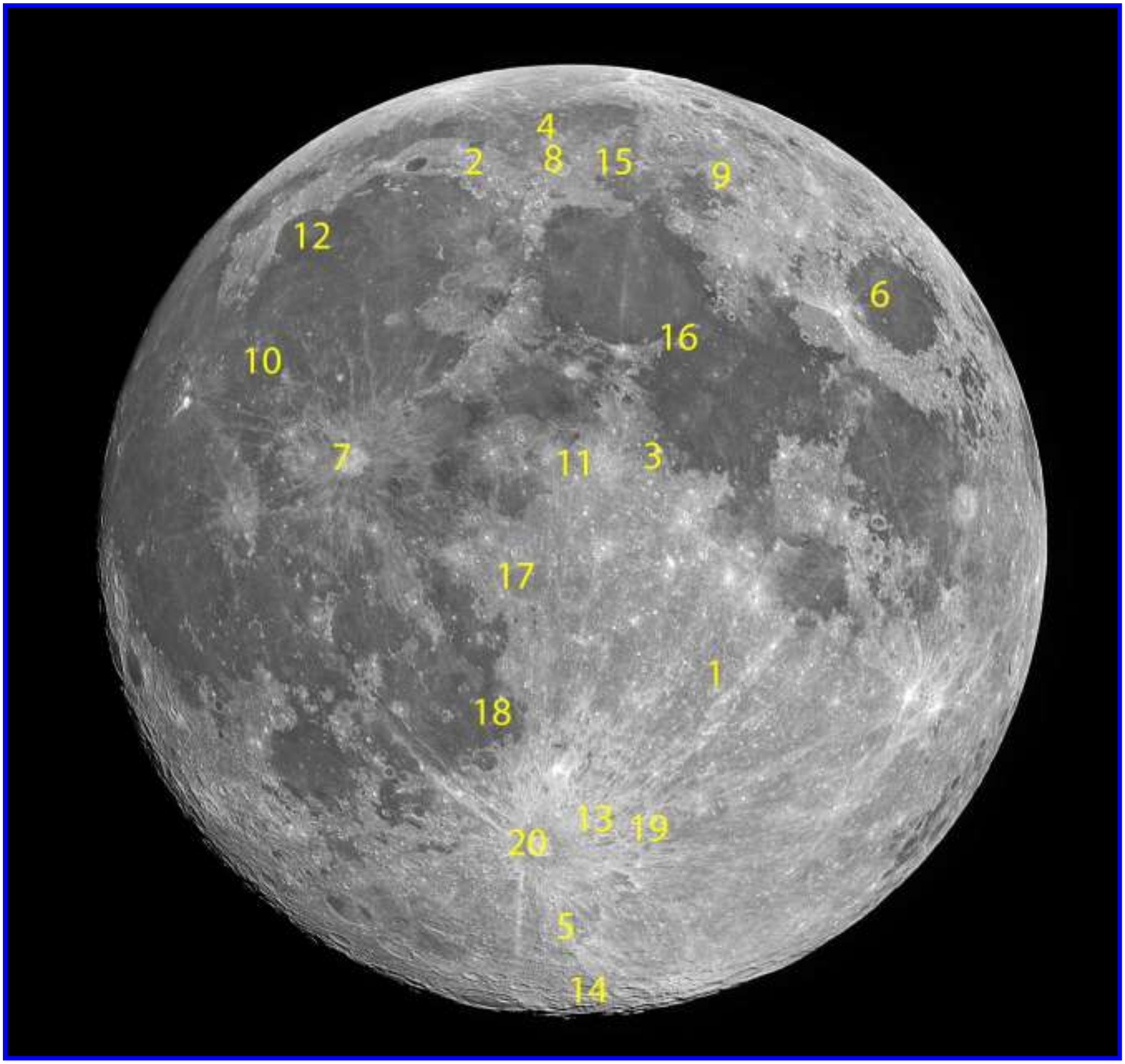
Mare Frigoris is the only mare that does not occupy a circular basin, it is an elongated strip of approximately 1500 kilometers that extends from the Lacus Mortis at its eastern end, passing through Aristoteles, Galle, Protagoras, Archytas, Timaeus, Birmingham, Fontenelle, La Condamine, Harpalus all the way to Sinus Roris in the west, with wonders like Plato and Sinus Iridum nearby. Mare Frigoris would be part of the Imbrium impact basin, and its north coast is covered by the material ejected by this impact. Let's share images of this area of the lunar north, sometimes forgotten due to its proximity to much more photogenic areas.

Please send articles, drawings, images, etc. to Alberto Anunziato and David Teske by **April 20, 2022** for the May 2022 issue of The Lunar Observer.



Sergio Babino

Key to Images In This Issue



1. Abulfeda	11. Hyginus
2. Alpes, Vallis	12. Iridum, Sinus
3. Ariadaeus, Rille	13. Maginus
4. Aristoteles	14. Moretus
5. Clavius	15. Mortis, Lacus
6. Crisium, Mare	16. Plinius
7. Copernicus	17. Ptolemaeus
8. Eudoxus	18. Recta, Rupes
9. Hall	19. Stöfler
10. Heim, Dorsa	20. Tycho