
7-Day
MOON

The 7-Day waxing crescent Moon

It's another hit-&-run observing evening here in my suburban backyard just N. of Copenhagen, Denmark (56N 12E). It's the **1. Day spring here on earth** (2020-03-01, 18:30 local CEST, UT+1), and the **7. Lunar day up on our 39% waxing Moon**. As has been the case the past week, the weather is now mostly overcast, but with some stripes of clear(ish) sky between the incoming banks of *Nimbostratus* clouds.

I've described the overall lunar **landscapes and geology** as seen on the 6-Day moon previously, so I won't focus on that this evening; Instead I plan to concentrate on some smaller features of interest along the terminator, which tonight passes through the eastern *Mare Frigoris*, then down along the W shore of *Serenitatis*, through the middle of the *Great Peninsula* (W of Nectaris) and finally through the *Cratered Southern Highlands* with the ancient pre-Nectarian impact basin *Mutus-Vlacq.*

1 *Crop:* Frigoris E

I start my sweep of the 7-Day terminator from the north, with the E part of Mare Frigoris at the center of the FOV. There are some **ancient pre-Nectarian large walled plains** in this region, most obvious: *De La Rue*, *Meton* and *W Bond* up N, but also *Alexander* at the N border of Serenitatis. The most conspicuous PN walled-plain impact however, is also the one most often overlooked, namely: **Lacus Mortis**.

This giant crater was lava-filled in upper Imbrian, and then recently (in the Copernican epoch) it received an almost bulls-eye impact coming in from the W and forming the central crater **Bürg**, that shows an W->E asymmetric distribution of the ejecta carpet, with a pair on N-S "butterfly wings". There's a long steep cliff / scarp running through the L. Mortis crater floor, which I imagine may have been caused by the Bürg impact (see transect T1 below). Also, there's a tension crack (graben: *Rima Bürg*) from central L. Mortis stretching SW through the crater wall (there's a pair of small volcanic cones each with a summit pit, right where the graben crosses the crater wall, but they are too small to be resolved by my 4" refractor).

Recently a couple of **lava pits** were discovered close to *Rima Bürg*; These may be entrances to an emptied lava channel, and maybe connected to a lava tube below the graben. It has been proposed that such caves might be used as a safe environment for settlement below the lunar surface. As can be seen on a transect (T2), the pits are 40-50m deep and 100m wide

2 *Crop:* Serenitatis

Sweeping south from the E Frigoris region, I now center the view on the **Serenitatis Basin**, which is of the same age as *Crisium* and *Nectaris* (i.e. the Nectarian epoch ~3.8 Byr). The NW part of my view is covered by ejecta "rubble" from the lower Imbrian Basin impact, and of course younger upper Imbrian lava flows have since filled up the Serenitatis Basin.

The oldest (3.5 Byr) and **darkest (i.e. high-titanium) lava basalts** can be seen along the SE "shores", from north of Posidonius, down past the Taurus-Littrow area and further south to Plinius. These old lava flows were accompanied by fire fountain volcanism, which has covered parts of the dark lava with even darker ash and glass bead deposits (DMD pyroclastics, most obvious in the *Taurus-Littrow* area and along the shore N of *Sulpicius Gallus.*

Finally, the lowest central part of Serenitatis was filled up by younger (3 Byr) **bright-hued lava flows**, which made the mare surface subside, creating a system of long arcuate rilles (Rimae) in the old lava shelf from *Plinius*, past *Menelaus* and to *Sulpicius Gallus*. The central lava fills also completely "drowned" the inner Serenitatis basin ring, leaving only a circle of basalt ridges marking the position of the ring.

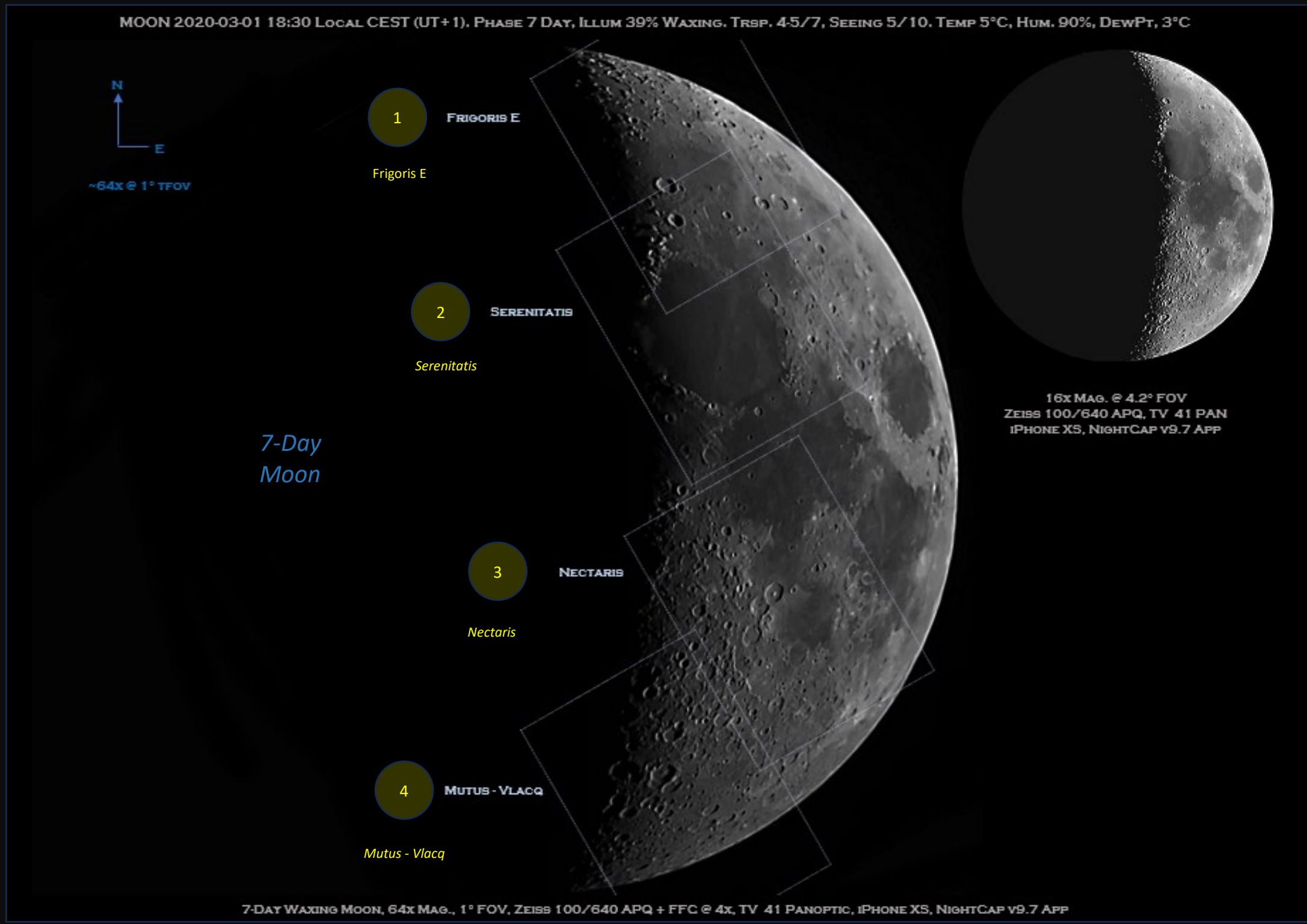
The upper Imbrian lava flooding also pressed up through the floors of old as well as contemporary craters around the Serenitatis basin, such as the Nectarian **Le Monnier and Maraldi** plus the upper Imbrian **Posidonius and Vitruvius**. The upwelling magma either completely flooded the craters (Le Monnier, Maraldi) or severely fractured the crater floor (Posidonius). Later epoch craters show more normal floors as seen for instance in Eratosthenian Plinius and Copernican Menelaus.

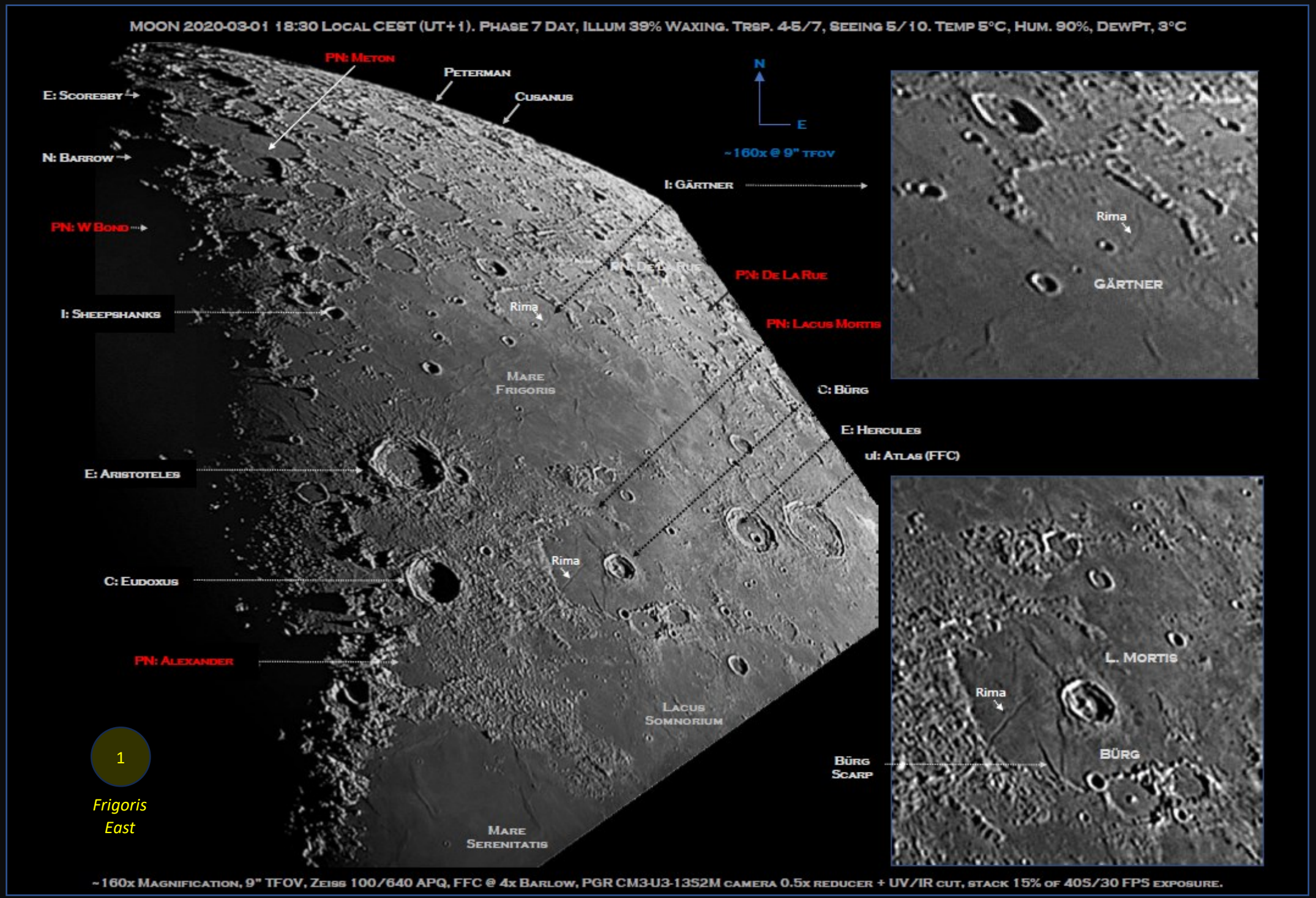
I made a couple of **transects** (using *LROC: QuickMap*) to further study some interesting features in the Serenitatis region:

The first shows the **FFC floor of Posidonius,** with an up-tilted lava plate and also an unusually twisted and turning lava channel caused by the erosion from eddies and vortices formed in hot low-viscosity fast-flowing and turbulent lava.

Next a cross-section of the Gardner Mega-dome, a large rough-textured elevated volcanic area with a probable caldera at the center. Other interesting volcanic formations are the Jansen volcanic complex and the Valentine Dome area, both of which I plan to study close-up on another (partly) cloudy night; a lot of these here lately, sigh...

Finally, I spent some time on the block-faulted highlands in the **Taurus-Littrow area** where the Apollo 17 landed, already 48 years ago this year. This is one of my favorite Lunar regions which I have studied many times; Tonight, I can clearly see *Bear Mountain* at the South Massif, N of which the Apollo 17 LM touched down in December 11. 1972, and explored the Lunar surface for the next 3 days. Hopefully it won't be many years now before Man again sets foot on our nearby satellite...


MOON 2020-03-01 18:30 Local CEST (UT+1). Phase 7 Day, Illum 39% Waxing. Trsp. 4-5/7, Seeing 5/10. Temp 5°C, Hum. 90%, DewPt, 3°C
N
E
~64x @ 1° TFOV
1
Frigoris E
Frigoris E
2
Serenitatis
Serenitatis
7-Day
Moon
3
Nectaris
Nectaris
4
Mutus - Vlacq
Mutus - Vlacq
16x Mag. @ 4.2° FOV
Zeiss 100/640 APQ, TV 41 PAN
iPhone XS, NightCap v9.7 App
7-Day Waxing Moon, 64x Mag., 1° FOV, Zeiss 100/640 APQ + FFC @ 4x, TV 41 Panoptic, iPhone XS, NightCap v9.7 App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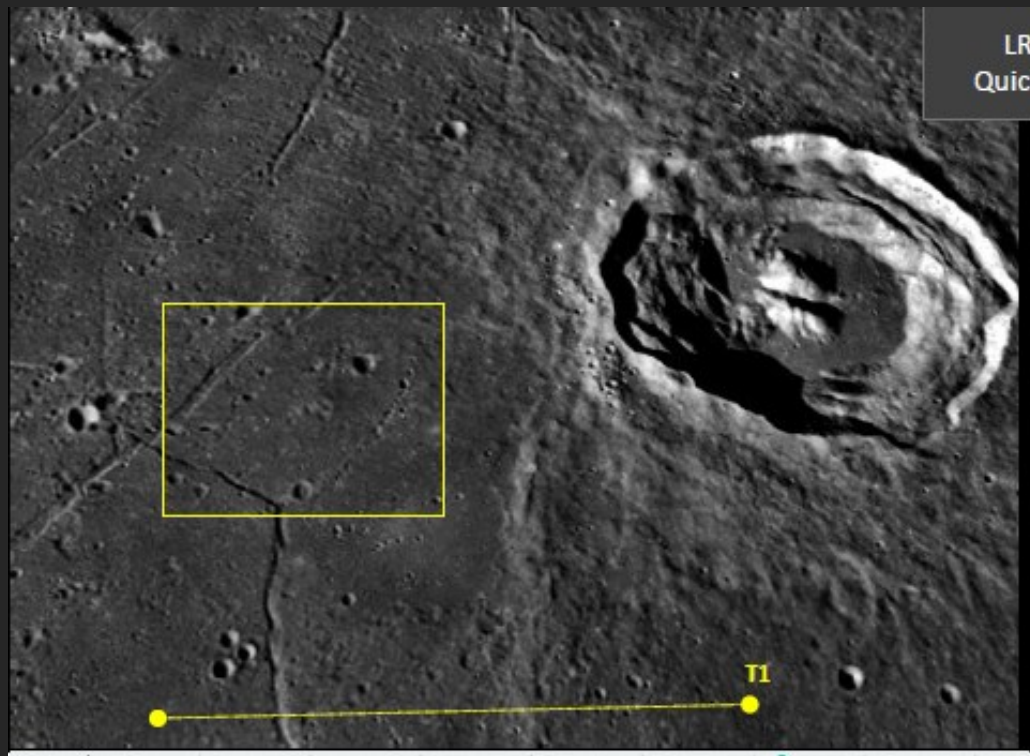
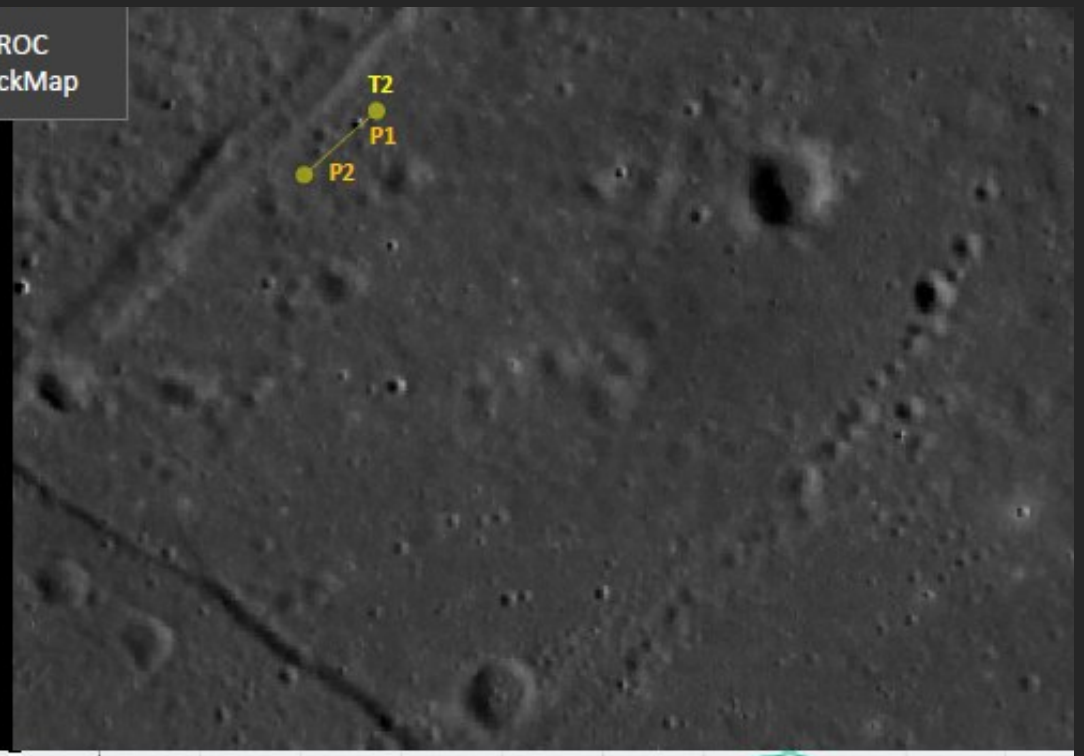
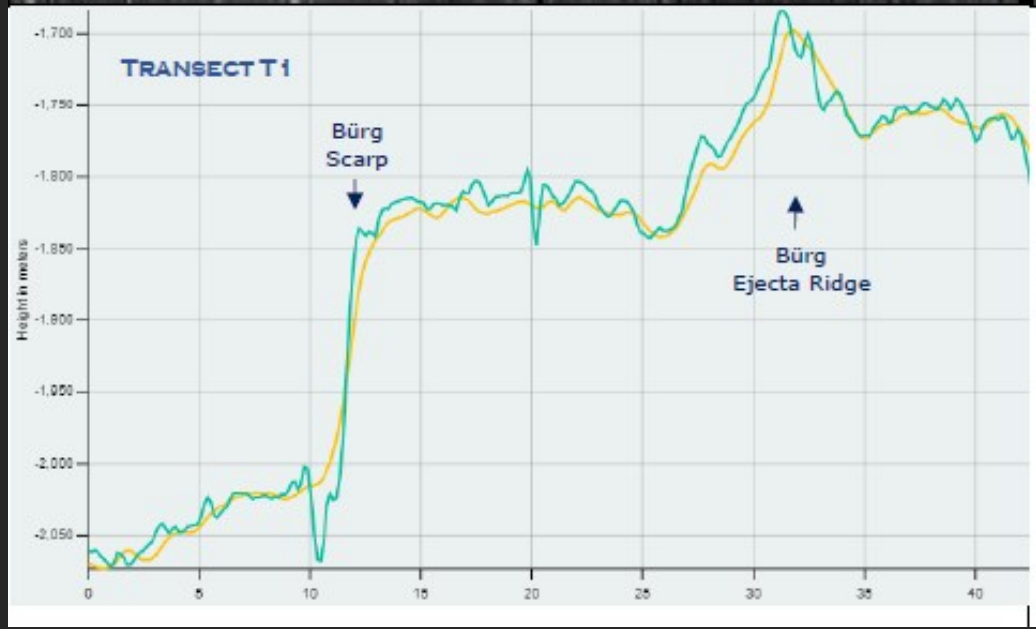
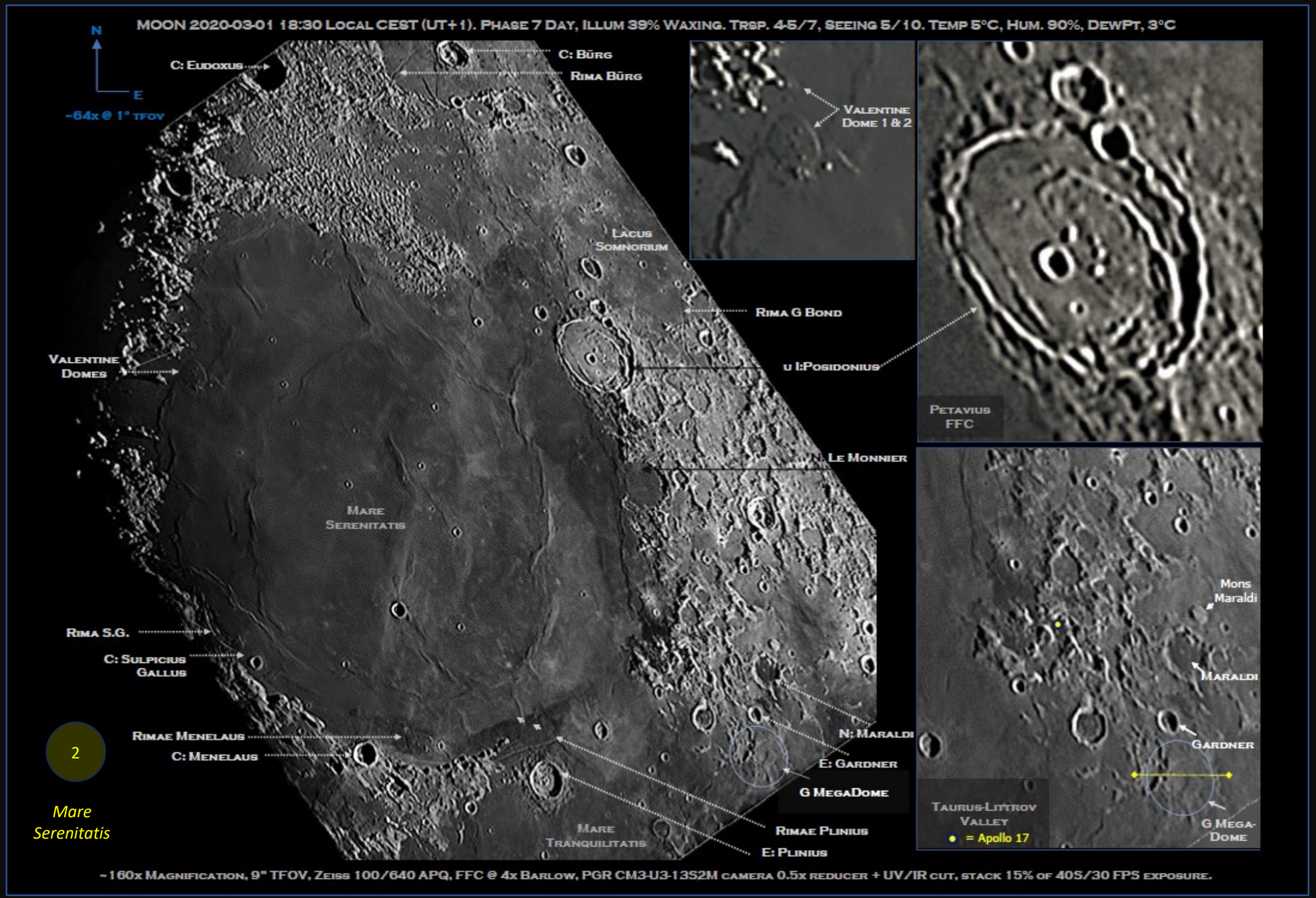
PN: METON
PETERMAN
CUSANUS
E: SCORESBY
N: BARROW
PN: W BOND
I: GÄRTNER
~160x @ 9" TFOV
N
E
I: SHEEPSHANKS
Rima
PN: DE LA RUE
PN: LACUS MORTIS
MARE FRIGORIS
C: BÜRG
E: HERCULES
ul: ATLAS (FFC)
E: ARISTOTELES
C: EUDOXUS
Rima
PN: ALEXANDER
LACUS SOMNORIUM
BÜRG SCARP
MARE SERENITATIS
Rima
GÄRTNER
Rima
L. MORTIS
BÜRG
1
Frigoris East
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 15% OF 405/30 FPS EXPOSURE.


LROC
QuickMap
T1


T2
P1
P2


TRANSECT T1
Bürg
Scarp
Bürg
Ejecta Ridge
Height in meters


TRANSECT T2
Pit
Pit?
P2
P1
Height in meters
Position along line in kilometers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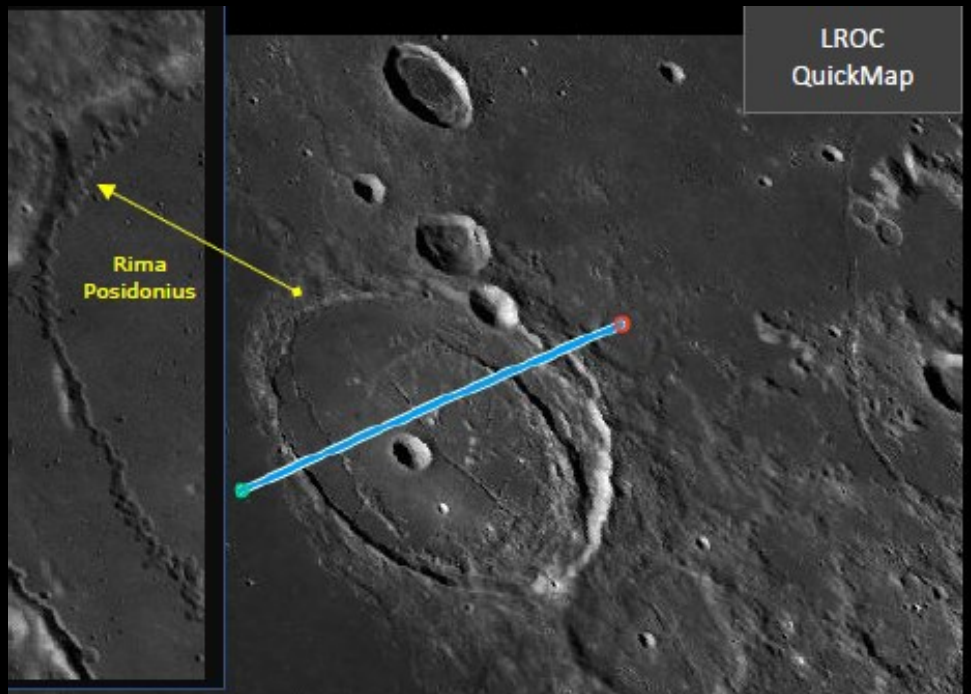
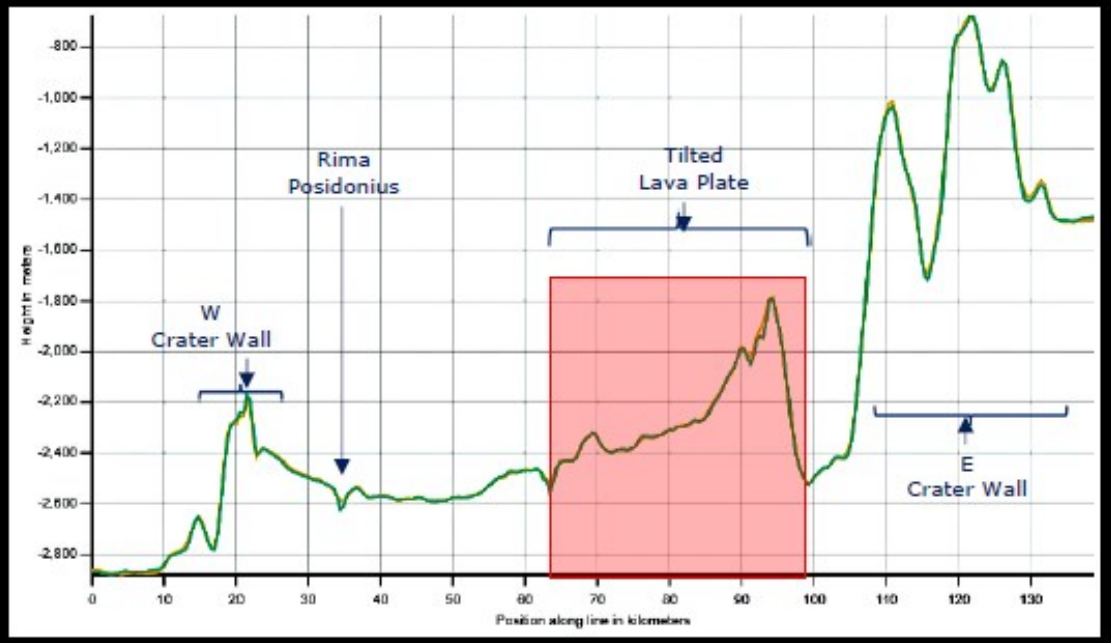
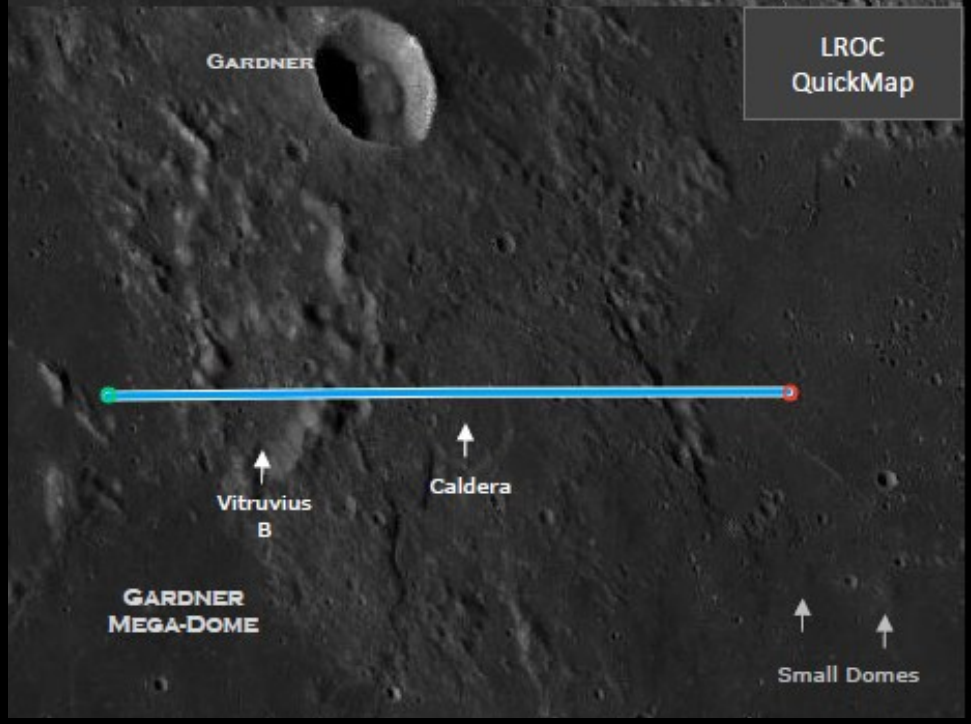
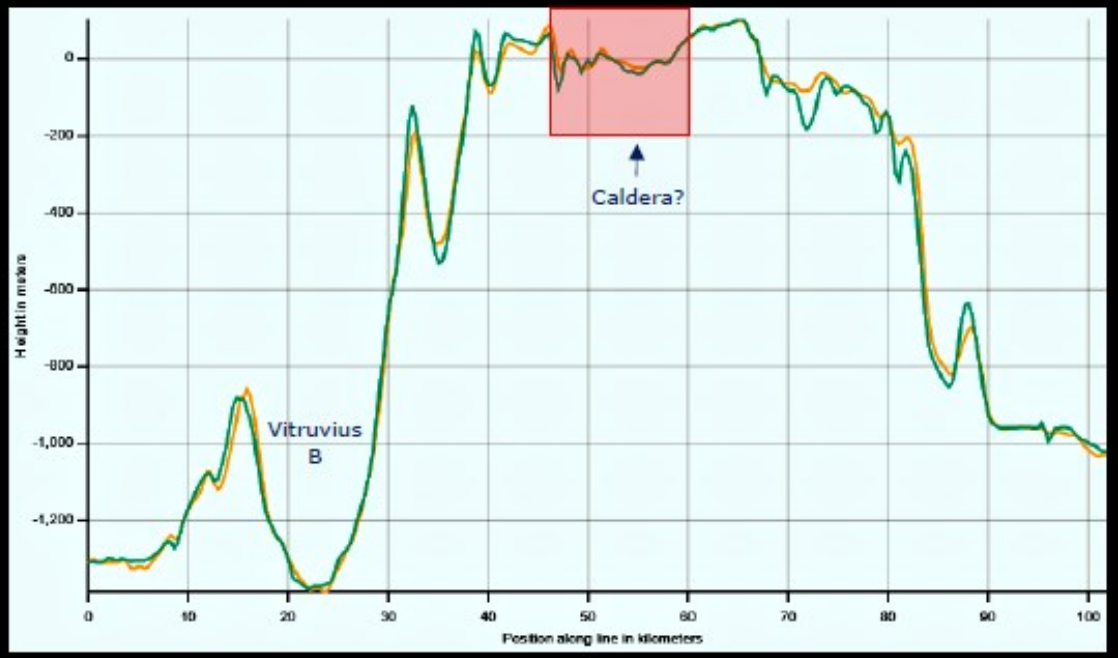
N
E
~64x @ 1° TFOV
C: EUDOXUS
C: BÜRG
RIMA BÜRG
VALENTINE DOME 1 & 2
LACUS SOMNORIUM
RIMA G BOND
VALENTINE DOMES
U I:POSIDONIUS
PETAVIUS FFC
N. LE MONNIER
MARE SERENITATIS
RIMA S.G.
C: SULPICIUS GALLUS
RIMAE MENELAUS
C: MENELAUS
N: MARALDI
E: GARDNER
G MEGADOME
RIMAE PLINIUS
E: PLINIUS
MARE TRANQUILITATIS
Mons Maraldi
MARALDI
GARDNER
G MEGA-DOME
TAURUS-LITTROV VALLEY
= Apollo 17
2
Mare Serenitatis
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 15% OF 40S/30 FPS EXPOSURE.


LROC
QuickMap
Rima
Posidonius


Rima
Posidonius
Tilted
Lava Plate
W
Crater Wall
E
Crater Wall
Height in meters
Position along line in kilometers


LROC
QuickMap
GARDNER
Vitruvius
B
Caldera
GARDNER
MEGA-DOME
Small Domes


Caldera?
Vitruvius
B
Height in meters
Position along line in kilometers

East Serenitatis

Taurus-Littrow and Posidonius

The E shore of Mare Serenitatis harbors several interesting sites, including the **Taurus-Littrow valley** (TLV) and the **Posidonius floor fractured crater** (FFC).

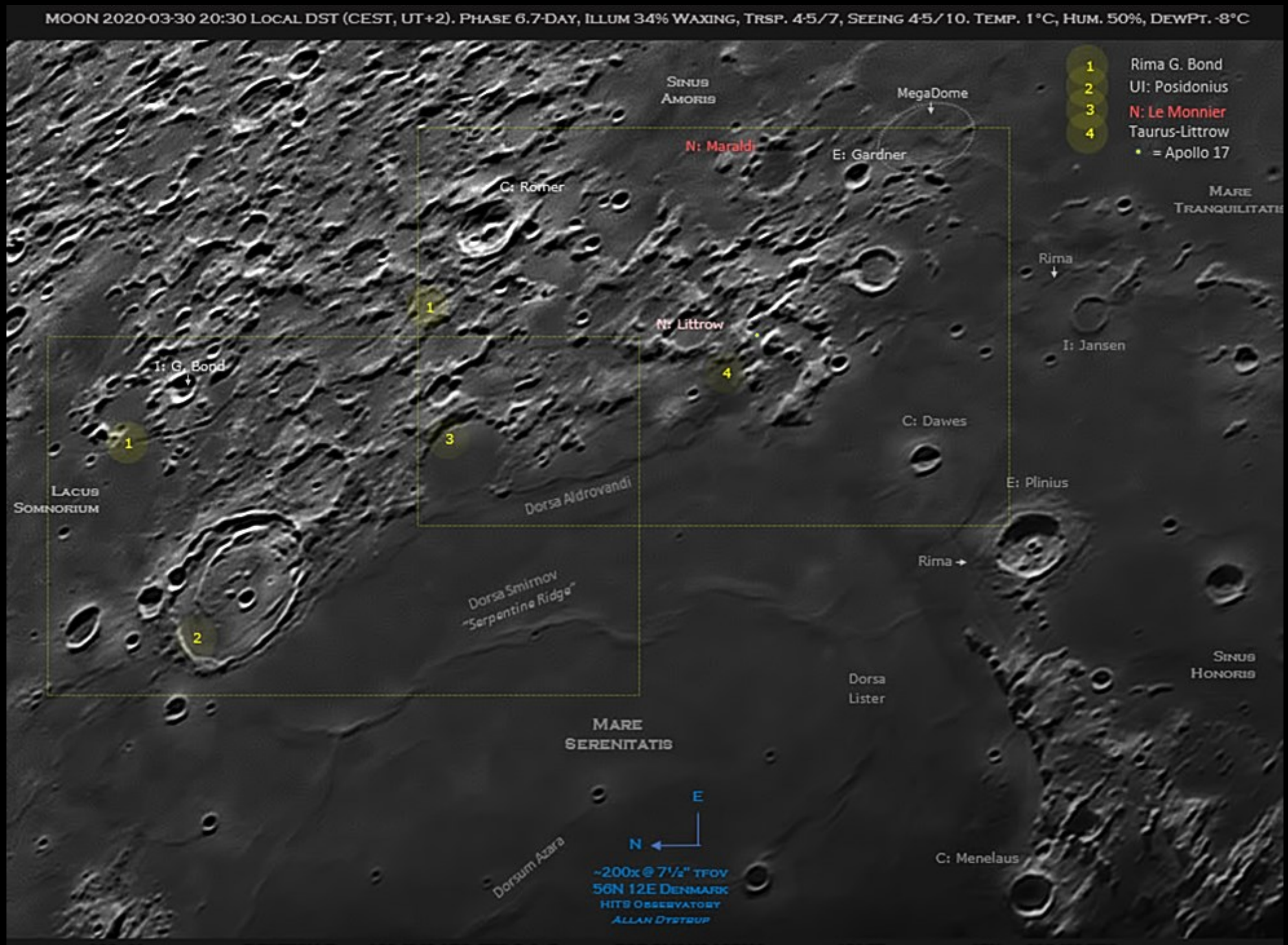
Taurus-Littrow

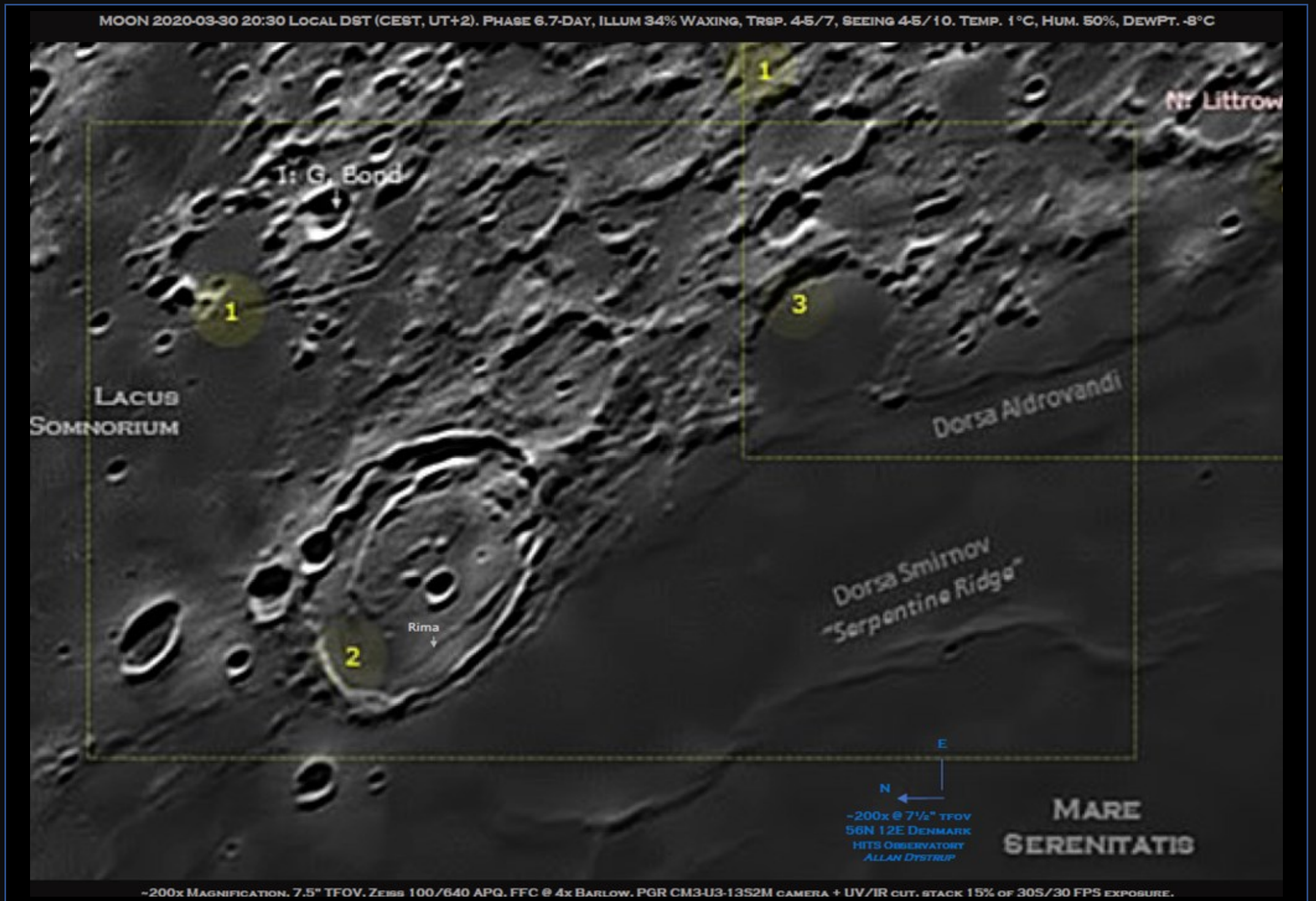
I have during previous observations spent many hours in the block-faulted highlands of the Taurus-Littrow area, where Apollo 17 touched down, already 48 years ago this year. This is one of my favorite Lunar regions, and tonight, I can clearly identify *Bear Mountain* at the South Massif, just N of which the Apollo 17 LM landed in December 11. 1972, and explored the Lunar surface for the next 3 days. Hopefully it won't be many years now before man again sets foot on our nearby satellite.

Taurus-Littrow Valley (TLV) was chosen as the final landing site for the Apollo project (A17) in an attempt to bracket the lunar time scale by sampling and dating both ancient lunar terra (uplifted Serenitatis basin floor in N. Massif?) and young eruptive volcanism (dark mantle deposits on TL valley floor?).

As it turned out, A17 succeeded in collecting 4.1 Byr crystalline material from old uplifted Serenitatis basin crust, but most of their "terra" samples from *N. Massif* and *Sculptured Hills* were complex, severely deformed and extensively melted multicomponent breccia ejecta from the Serenitatis (3.86 Byr) and later Imbrium (3.84 Byr) impacts. The DMD on the TLV floor turned out to be not so young 3.64 Byr pyroclastic material mixed up in the regolith and mostly exposed by excavation of lunar cratering. Below the regolith in the TLV was found a 1.4 Km thick and 3.7 Byr old dark titanium-rich lava layer; This dark lava is also seen along the shore of *Mare Serenitatis*, whereas it has been overlaid at the center of the mare by a younger and brighter lava flooding. At the foot of the S. Massif is seen a landslide wedge of bright material which was also sampled by A17; This is thought be ejecta from the *Tycho* impact, which was thus dated to Copernican ~109 Myr age.

So many exciting results, so much yet to be learned... As Don E. Wilhelms writes*: "By the time of Apollo 17 a magnificent and sophisticated network of rocketry, flight operations, geological and geophysical support, and geologic laboratory analysis was functioning with smooth precision. Now it was time to shut it all down and turn out the lights. Let each of us reflect once again on the marvel of it. It could not be done today."* So sad.


MOON 2020-03-30 20:30 LOCAL DST (CEST, UT+2). PHASE 6.7-DAY, ILLUM 34% WAXING, TRSP. 4-5/7, SEEING 4-5/10. TEMP. 1°C, HUM. 50%, DEWPT. -8°C
1 Rima G. Bond
2 UI: Posidonius
3 N: Le Monnier
4 Taurus-Littrow
• = Apollo 17
SINUS AMORIS
MegaDome
N: Maraldi
E: Gardner
C: Romer
MARE TRANQUILITATIS
Rima
N: Littrow
I: Jansen
I: G. Bond
C: Dawes
E: Plinius
LACUS SOMNORIUM
Dorsa Aldrovandi
Rima
Dorsa Smirnov
"Serpentine Ridge"
SINUS HONORIS
Dorsa Lister
MARE SERENITATIS
E
N
Dorsum Azara
C: Menelaus
~200x @ 7½" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYSTRUP
~200x MAGNIFICATION, 7.5" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA + UV/IR CUT, STACK 15% OF 30S/30 FPS EXPOSURE.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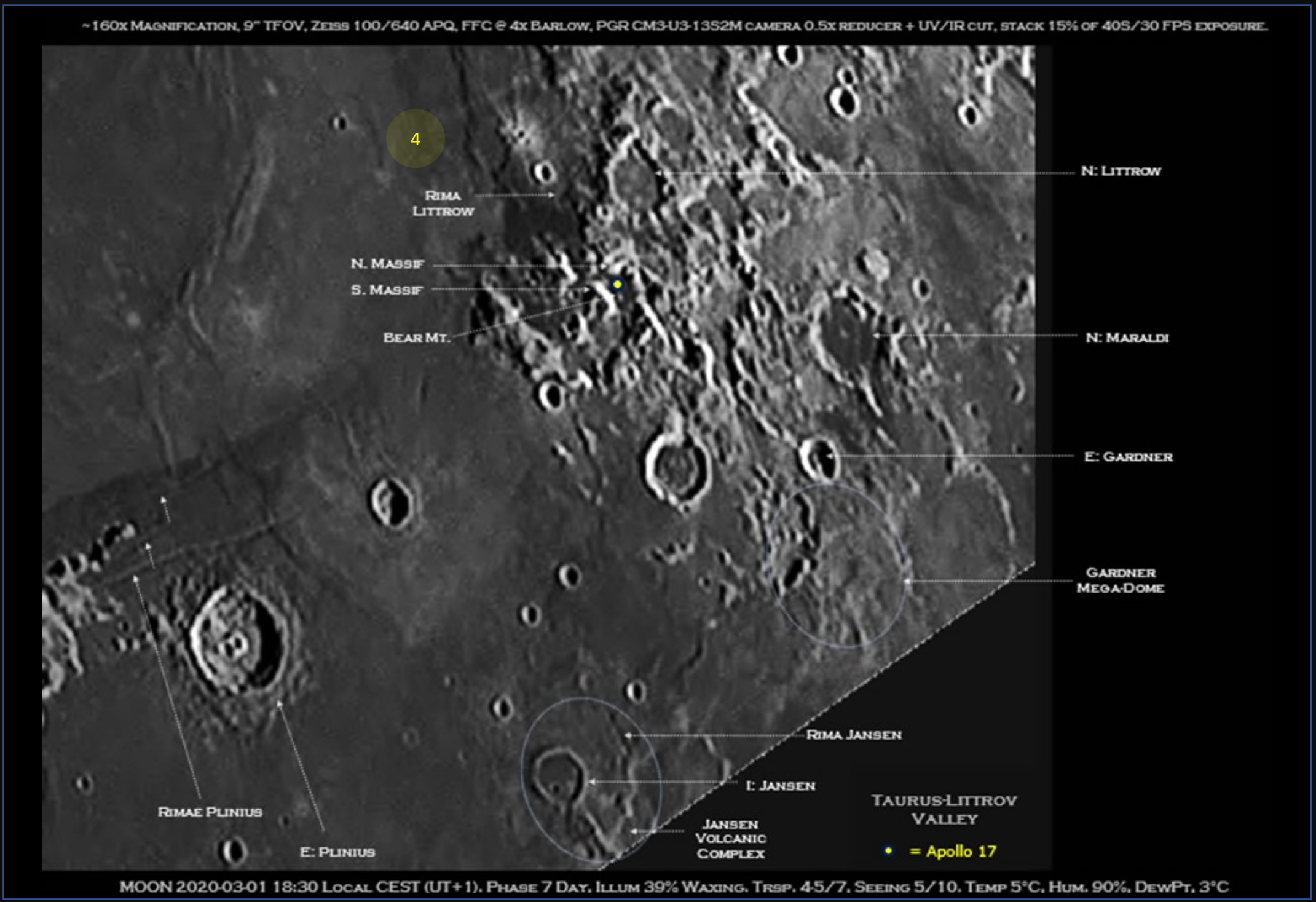
1
Nr Littrow
1: G. Bond
1
3
LACUS SOMNORIUM
Dorsa Aldrovandi
Dorsa Smirnov
"Serpentine Ridge"
Rima
2
E
N
~200x @ 7½" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYSTRUP
MARE SERENITATIS
~200x MAGNIFICATION. 7.5" TFOV. ZEISS 100/640 APQ. FFC @ 4x BARLOW. PGR CM3-U3-13S2M CAMERA + UV/IR CUT. STACK 15% OF 30S/30 FPS EXPOSURE.


~160x Magnification, 9" TFOV, Zeiss 100/640 APQ, FFC @ 4x Barlow, PGR CM3-U3-13S2M camera 0.5x reducer + UV/IR cut, stack 15% of 405/30 FPS exposure.
4
N: Littrow
Rima Littrow
N. Massif
S. Massif
Bear Mt.
N: Maraldi
E: Gardner
Gardner Mega-Dome
Rima Jansen
I: Jansen
Taurus-Littrov Valley
Jansen Volcanic Complex
= Apollo 17
Rimae Plinius
E: Plinius
MOON 2020-03-01 18:30 Local CEST (UT+1). Phase 7 Day. Illum 39% Waxing. Trsp. 4-5/7. Seeing 5/10. Temp 5°C. Hum. 90%. DewPt. 3°C

MOON 2020-03-30 20:30 Local DST (CEST, UT+2). Phase 6.7-Day, Illum 34% Waxing, Trsp. 4-5/7, Seeing 4-5/10. Temp. 1°C, Hum. 50%, DewPt. -8°C

~400x Magnification, 7.5" TFOV, Zeiss 100/640 APQ, FFC @ 4x + TV 2x Barlow, PGR CM3-U3-13S2M camera + UV/IR cut, stack 15% of 30S/30 FPS exposure.

The 7-Day Moon

3 Nectaris

Sweeping from Serenitatis south along the terminator, I now place the pre-Nectarian **Tranquilitatis** up north in the field of view, and Nectaris down SE. Both of these impact basins were filled with lava in middle-Imbrium, where the uprising mantle basalt also affected existing craters, totally covering a Nectarian crater like *Lamont* and fracturing the floors of others such as the lower Imbrian *Ritter and Sabine* (all in SW Tranquilitatis).

Tranquilitatis (being the deepest basin) was further flooded with mare basalt in upper Imbrium, where after the thick lava cover in central Mare Tranquilitatis subsided, creating arcuate tension cracks along the shore (such as *Rimae Hypatia*), and also crust conduits through which lava could rise and form domes like the *Arago α and β* shield volcanoes.

Nectaris, being a smaller and shallower ("drier") basin, shows only a weak inner wrinkle ridge ring, but it has preserved parts of its outer 3-ring structure, such as the *Altai Scarp* towards the SW. The small Nectaris did not experience a central sinking and thus does not feature any peripheral arcuate rilles or volcanic domes along the shore, but the lava flows did almost drown the large Nectarian craters *Torricelli R, Daguerre* and *Fracastorius*; The latter is located right on the S shore, and after the lava fill, half of the crater floor tilted a bit towards central Nectaris, causing a crack in the lava that I can still *just* glimpse today. There are a few signs of pyroclastic deposits accompanying the Nectaris lava fill, -- notably a dark mare patch N of *Daguerre* and the dark haloed crater *Baumont L*.

Great Peninsula - E

Totally dominating the borderland between *Tranquilitatis* and *Nectaris* is the large and magnificent Eratosthenian complex crater: **Theophilus**, complete with spectacular terraced walls and a flat floor with several broad central peaks. The impact has left a ring of melt and boulders surrounding the crater, plus a large ejecta carpet with radiating ridges and grooves fanning out, most obviously past the lower N rim into *Sinus Asperitatis* all the way to the buried crater *Torricelli R*, and also far E to *Daguerre*.

Looking at the eastern cratered highland of **the Great Peninsula**, a couple of interesting features are: the *Abulfeda* crater and the region N of the *Descartes* crater. Just north of *Descartes* is seen an unusual patch/wedge of light-hued hilly terrain surrounded by smother plains. Before Apollo 16 (April 1972) these were thought to be volcanic formations of piled-up viscous lava blocks upon older and lower viscosity ash/lava flows (the so-called Cayley formation). Apollo 16 however discovered that the origin of these surface features was not volcanic but rather impact breccias and melt ejected from surrounding basins (*Nectaris, Imbrium*) mixed up with anorthositic crust of local origin.

Some interesting **catenae** can be seen in the highland areas, most conspicuous *Catena Abulfeda*, which was probably formed by a comet being shredded to a row of pieces (like we've seen on Jupiter), forming a crater chain when crashing into the lunar surface. Another one is *Vallis Capella*, which is probably a chain of secondary craters created by the Imbrium impact.

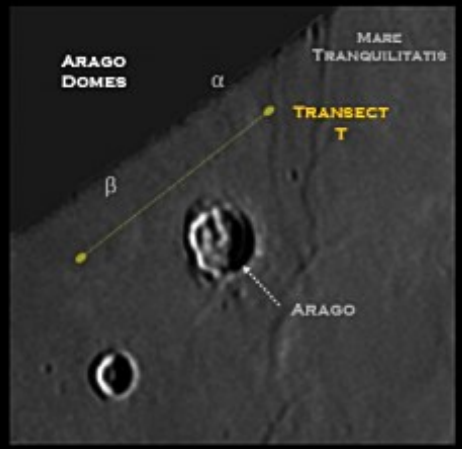
Mutus-Vlacq 4

Completing my sweep of the 7-Day Moon I finally arrive at the **Southern Crated Highlands** east of the Tycho-Clavius area. I can recognize the faint outline of two underlying ancient early **pre-Nectarian impact basins: *Mutus-Vlacq*** (MV) **and *Werner-Airy*** (WA). The difference in mean surface height between the MW basin and the surrounding highland is only ~400m (see transect below), so it helps to know where to look to recognize these features.

These early pre-Nectarian basin impacts must have covered the surroundings with crust ejecta, but the landscape has since been thoroughly churned up by **cratering impacts** from late pre-Nectarian (*Stöfler, Licetus, Mutus, Nearch, Vlacq* etc.) through the Nectarian (*Macrolytus, Barocius*), Imbrian (*Cuvier*) and up to the young Copernican (*Tycho*) epoch. Interestingly the Southern Cratered Highlands have not been significantly affected by ejecta from later, large basin impacts such as *Imbrium* and *Nectaris*, so the surface today is still comprised of pummeled but mostly unmodified early lightweight aluminum-rich lunar crust.

Arago Domes

Note how the Tranquillitatis mare surface is slanting downwards towards NE due to the central mare subsidence in upper Imbrium.



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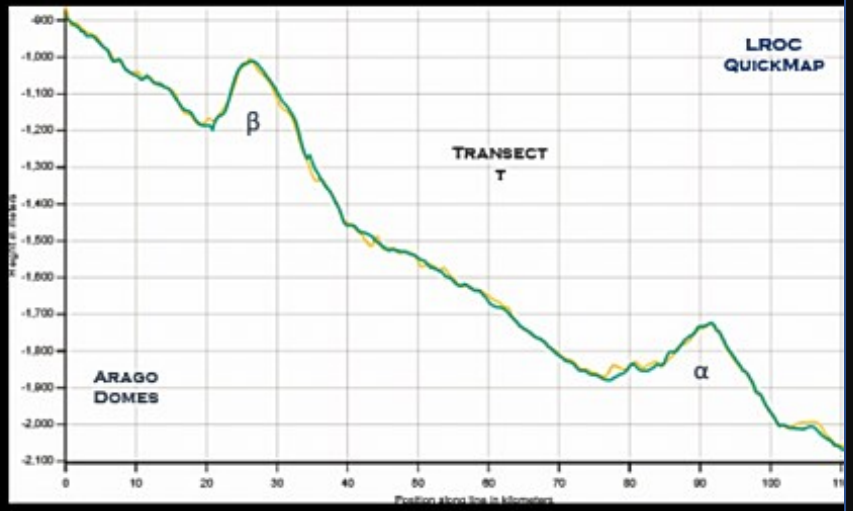

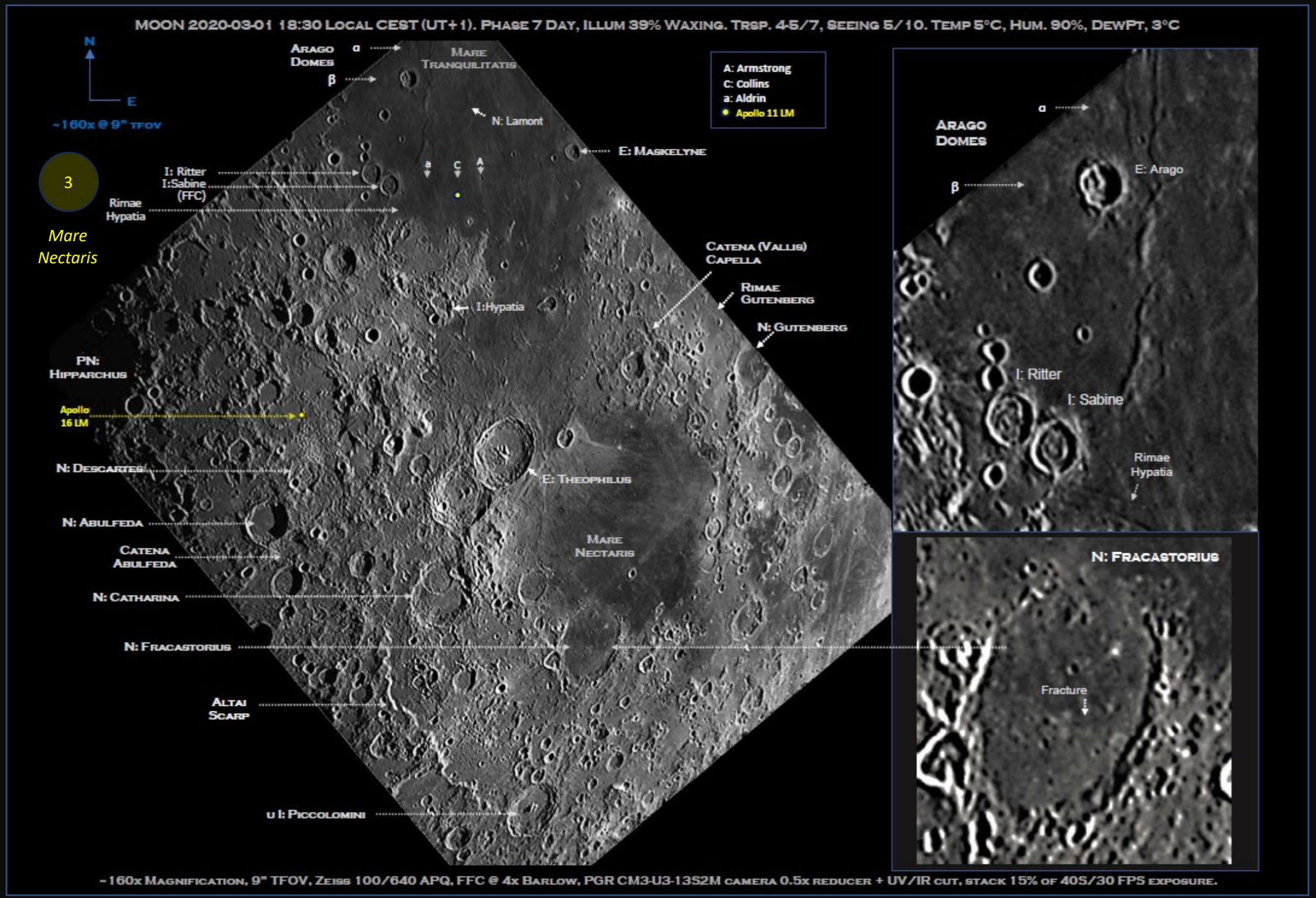
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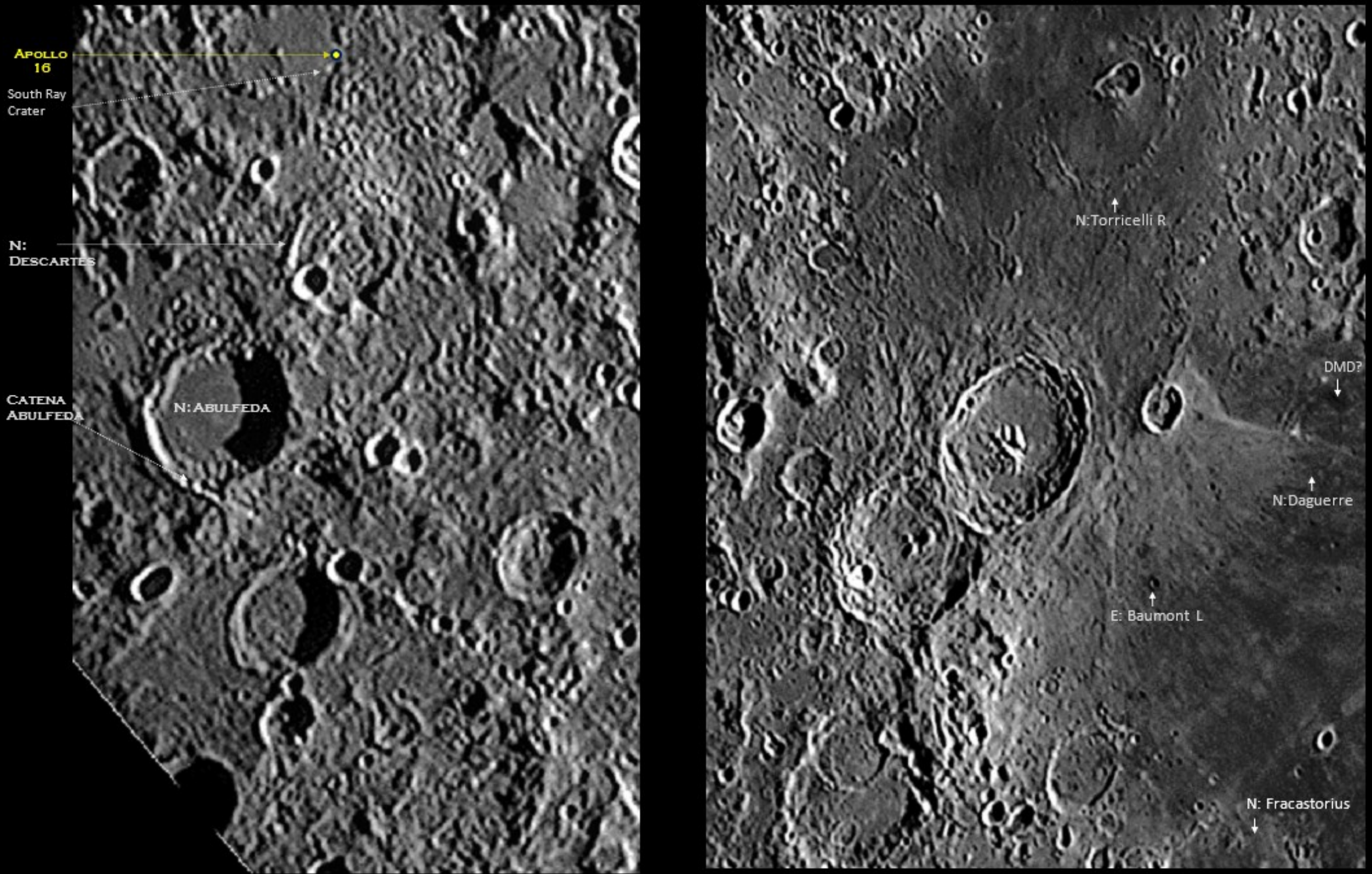
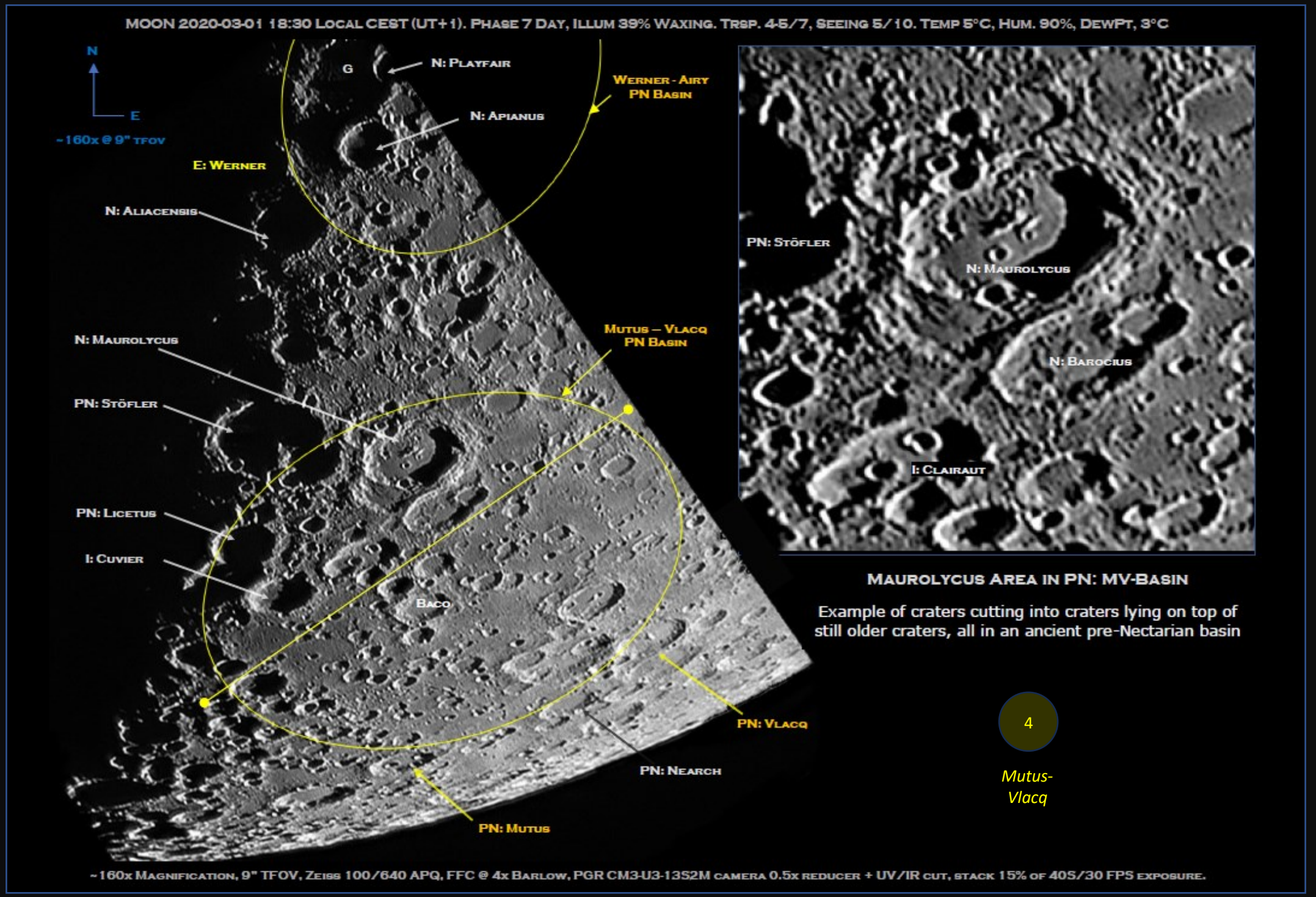
N
E
~160x @ 9" TFOV
3
Mare Nectaris
ARAGO DOMES
α
β
MARE TRANQUILITATIS
N: Lamont
E: MASKELYNE
A: Armstrong
C: Collins
a: Aldrin
Apollo 11 LM
I: Ritter
I:Sabine
(FFC)
Rimae Hypatia
CATENA (VALLIS) CAPELLA
RIMAE GUTENBERG
I:Hypatia
N: GUTENBERG
PN: HIPPARCHUS
Apollo 16 LM
N: DESCARTES
E: THEOPHILUS
N: ABULFEDA
CATENA ABULFEDA
MARE NECTARIS
N: CATHARINA
N: FRACASTORIUS
ALTAI SCARP
υ I: PICCOLOMINI
ARAGO DOMES
E: Arago
I: Ritter
I: Sabine
Rimae Hypatia
N: FRACASTORIUS
Fracture
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 15% OF 40S/30 FPS EXPOSURE.

MOON 2020-03-01 18:30 LOCAL CEST (UT+1). PHASE 7 DAY, ILLUM 39% WAXING. TRSP. 4-5/7, SEEING 5/10. TEMP 5°C, HUM. 90%, DEWPT, 3°C



~160X MAGNIFICATION. 9" TFOV. ZEISS 100/640 APQ. FFC @ 4X BARLOW. PGR CM3-U3-13S2M CAMERA 0.5X REDUCER + UV/IR CUT. STACK 15% OF 40S/30 FPS EXPOSURE.


MOON 2020-03-30 20:30 Local DST (CEST, UT+2). Phase 6.7-Day, Illum 34% Waxing, Trsp. 4-5/7, Seeing 4-5/10. Temp. 1°C, Hum. 50%, DewPt. -8°C
Mare Nectaris
Fracastorius
E
N
Theophilus
Cyrillus
Catharina
~200x Magnification, 7.5" TFOV, Zeiss 100/640 APQ, FFC @ 4x + TV 2x Barlow, PGR CM3-U3-13S2M camera + UV/IR cut, stack 15% of 30S/30 FPS exposure.


MOON 2020-03-01 18:30 LOCAL CEST (UT+1). PHASE 7 DAY, ILLUM 39% WAXING. TRSP. 4-5/7, SEEING 5/10. TEMP 5°C, HUM. 90%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
G
N: PLAYFAIR
WERNER - AIRY PN BASIN
N: APIANUS
E: WERNER
N: ALIACENSIS
N: MAUROLYCUS
MUTUS – VLACQ PN BASIN
PN: STÖFLER
PN: LICETUS
I: CUVIER
BACO
PN: VLACQ
PN: NEARCH
PN: MUTUS
PN: STÖFLER
N: MAUROLYCUS
N: BAROCIUS
I: CLAIRAUT
MAUROLYCUS AREA IN PN: MV-BASIN
Example of craters cutting into craters lying on top of still older craters, all in an ancient pre-Nectarian basin
4
Mutus-Vlacq
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 15% OF 40S/30 FPS EXPOSURE.

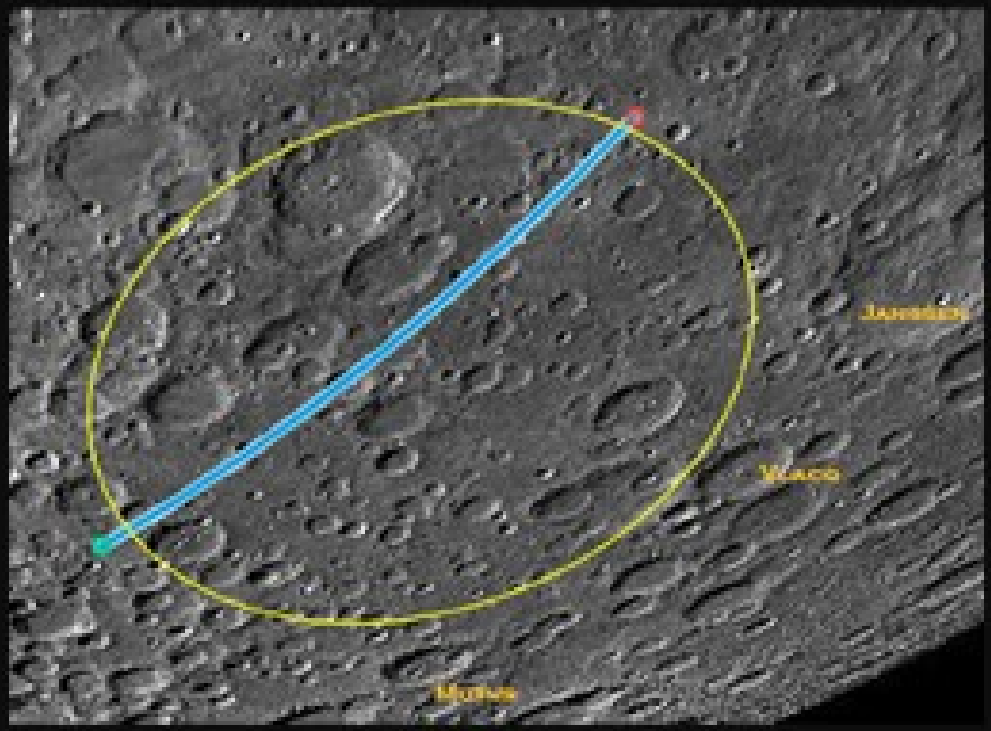
The Janssen Glider Gun...

Yesterday, while observing the 7dy moon with my Classic Zeiss Jena AS63/840, I began wondering about the origin of the **Janssen crater chain,** which was very prominent, -- almost like *a glider gun,* for those of you who remember Conway's *"Game of Life"...*

Pardon the fuzzy image -- I shot it through a 16mm orthoscopic EP, handheld with my cell phone. at 89x magnification; Look at the chain...I mean, yes, it could be a random alignment of morphologically similar craters, but it's so strikingly linear, that one would suspect a common origin, maybe somewhat like the comet Shoemaker-Levy collision with Jupiter in 1994..., or ?

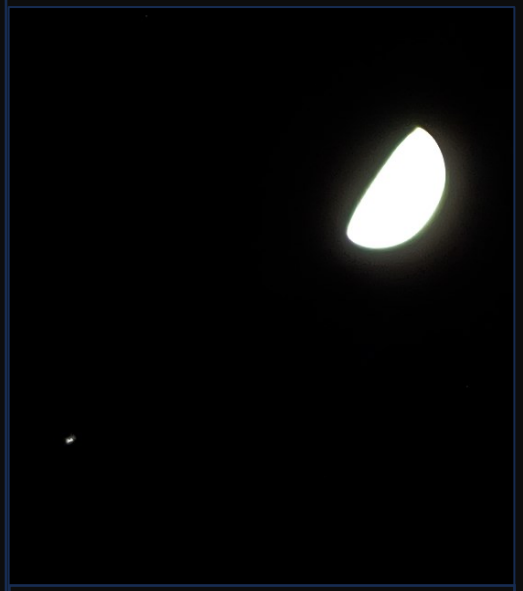
There are other crater chains in the neighborhood, noticeably the *Vallis Rheita*, but they are thought to be created by Mare Nectaris ejecta, and the orientation of the Janssen crater chain does not line up with these.

Mutus - Vlacq

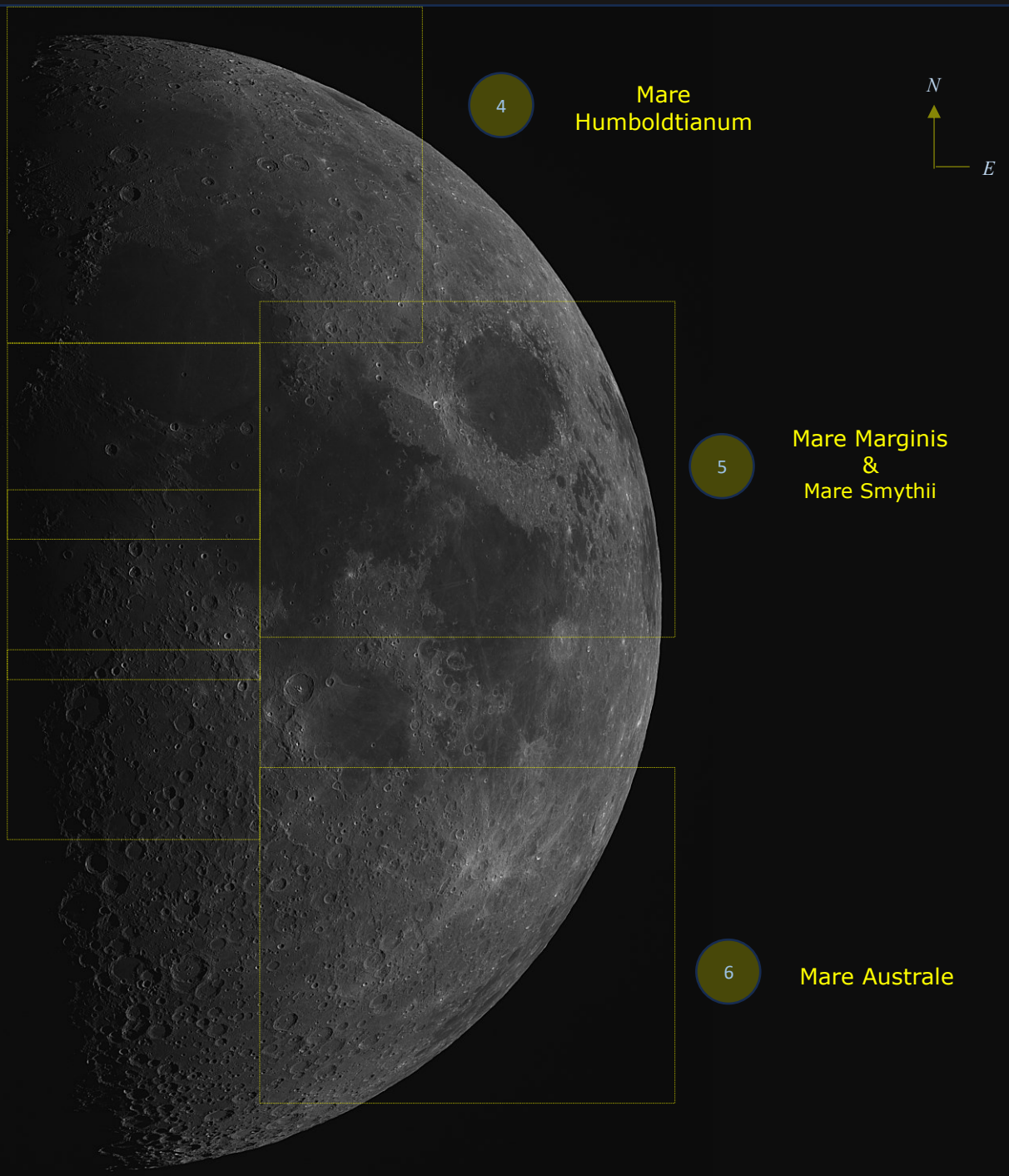


MOON 2024-01-18 15:30 DAYLIGHT LOCAL CEST (UT+1) , PHASE 7.4 DY 1.st QUARTER, ILLUM. 56% TRSP. 4/7, SEEING 6/10, TEMP. -2°C, HUM 86%, DEWPT -4°C, CALM

FULL IMAGE RESOLUTION HERE:
https://www.flickr.com/photos/139500911@N04/53472302612/in/datetaken-public/lightbox/



Moon-Jupiter Conjunction, 2024-01-18 19:00



HITS OBSERVATORY
56N 12E, COPENHAGEN DENMARK

Allan Dystrup

~1° FOV, ZEISS 100/640 APQ + ZEISS 2x BARLOW + IMX 183MM CAM 5500x3800px 90s @ 30 FPS + GREEN 500nm BANDPASS & UV/IR CUT, AS!3 25% STACK SHARPENED

The 1Q MOON, January 2024

It's mid-January (2024-01-18, 15:30 CEST/UT+1), and I've set up my small 4" refractor in the backyard for a closer look at the 1. Quarter Moon (7.4 day ~56% illumination) in broad daylight. It's a frosty ~-2°C afternoon with snow on the ground, but a clear blue sky with medium transparency and seeing.

I put a Zeiss 2x Barlow on the 100/640mm telescope thus reaching f/12.8, and with my TV 41mm Panoptic, I get a nice 31x view of the Moon in a 2° FOV; Substituting the eyepiece with my small IMX 183 monochrome camera, I get the half-moon at ~60x magnification in a good 1.2° FOV (setting the ROI of the camera to 5.5 x 3.8 Kpx). To reduce the glow of the blue sky, I apply a 500nm green bandpass filter, thus increasing the contrast of the view.

The terminator on the 1Q Moon passes through several interesting areas:

1 Haemus Mountains *(Imbrium Sculpture)*

The *Haemus Mountains* are found at the south-western border of *Mare Serenitatis*; They consist of several long NE-SW oriented low mountain ridges formed by material blasted out 3.85 billion years ago in the excavation of the Imbrium basin.

The Imbrium ejecta sheet created a near-surface flow of melted rock and boulders that lined up in striated chains of lumpy hills, separated by elongated walled troughs (now named '*Lakes'* and '*Sinus'*), all radiating from Imbrium as part of the 'Imbrium Sculpture'.

The ejecta 'tsunami' also blasted, eroded and filled in several preexisting craters (such *as Julius Caesar, Boscovich,* and other degraded but unnamed crater ruins).

2 Rilleland

"Rilleland" is a term coined by *Charles Wood* for the Lunar landscape between the crater Julius Caesar and Sinus Medii, where we find three different rille systems:

1. The Ariadaeus Rille is a ~4.5 km wide and 0.8 km deep parallel fault ('graben') formed by horizontal forces pulling apart the crumbled upper crust (megaregolith) formed by the Imbrium ejecta (see #1: Haemus Mts.).
2. The Hyginus Rille consists of a section parallel to the Ariadaeus Rille (and connected to this by a narrow and shallow diagonal branch), plus another section up towards central *Mare Vaporum*, parallel to the dark Imbrium Sculpture mountains SE of Vaporum. The Hyginus Rille looks like two graben segments connected at the Hyginus crater, but this interpretation is complicated by the presence of several rimless collapse pits of internal origin along the rille segments (some of which can just be glimpsed on my image). The pits look like small volcanic calderas, so the Hyginus faults and subsidence has probably been accompanied by an upwelling and small eruptions of lava.
3. The Triesnecker Rilles is an intertwined system of mostly straight and narrow (~1 km wide) rilles. They probably arose as tension cracks formed when the lava lake in NE Sinus Medii cooled down, and maybe the cracking was reinforced by magma uplifting the surface and/or by the impact that formed the 26 km wide Triesnecker crater (?).

3 Central Highlands

The central *Great Peninsula* of lunar highlands was formed by repeated overlaying of ejecta sheets from surrounding basin excavations: from Gargantuum, Nubium, and Tranquilitatis to Serenitatis, Nectaris and lastly Imbrium. This ~1.5 - 2 km deep debris layer of fragmented Lunar crust (megaregolith) is pockmarked by many large, old and ruined craters with a sprinkling of smaller, newer and brighter ones.

On my image can be seen good examples of two highland landscape types created largely by Imbrium (and maybe Nectaris) ejecta; These lunar crust types were sampled by the crew of Apollo 16:

1. the light-hued and smooth *Cayley* Plain Formation, created by mostly impact melt
2. the furrowed *Descartes* Mountain Formation, consisting of fragmental hummocky impact debris.

Many of the craters in the Central Highlands (such as *Abulfeda*) have flat floors formed by primarily Imbrium ejecta that have filled in the craters, and thereby buried their terraces and central peaks. Note though that some flat-floored craters (like *Albateginus*) are younger that the Imbrium Impact, and thus their floor was probably covered, not by Imbrium ejecta, but by volcanic ash and lava fill.

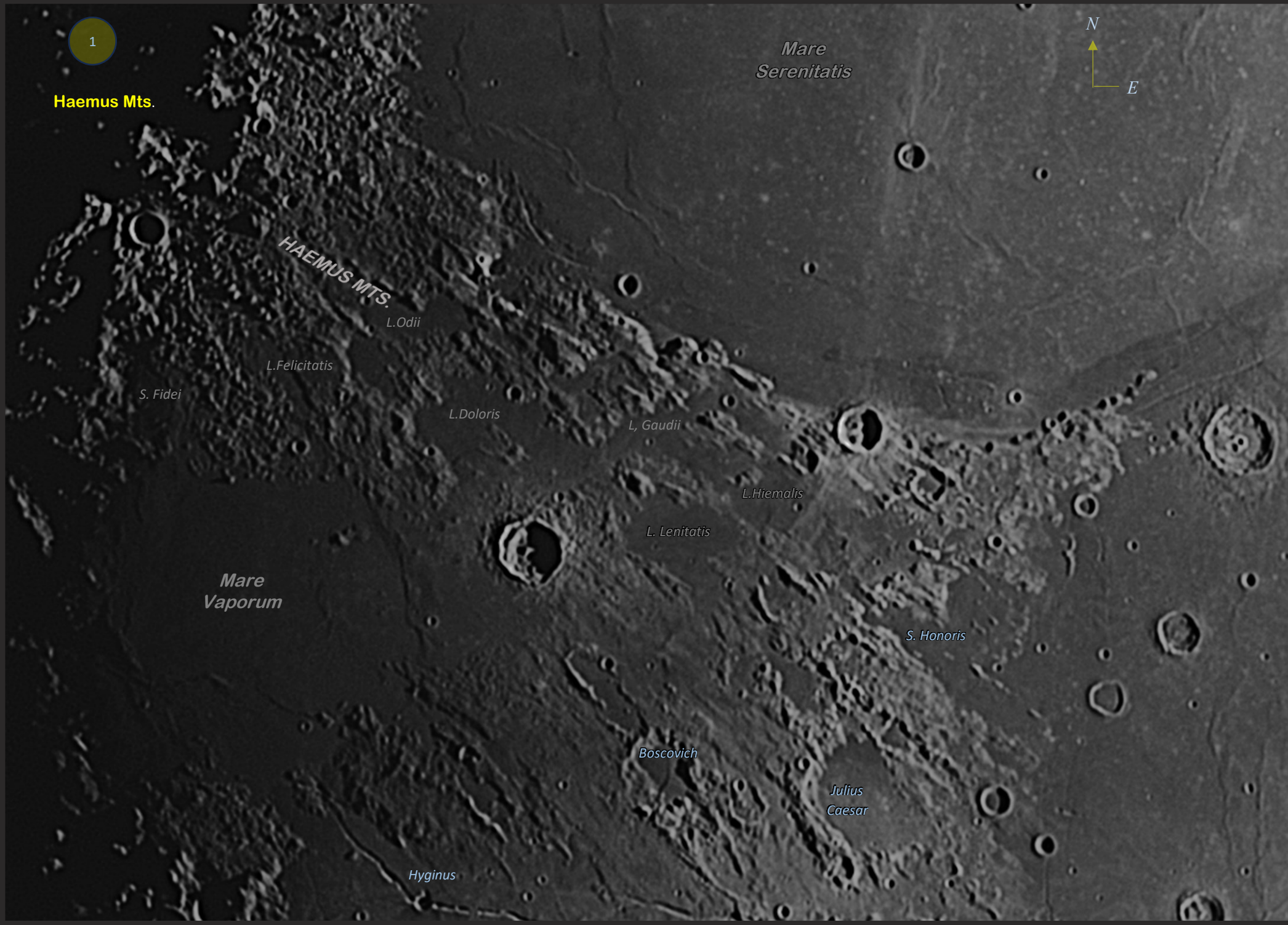
The 210 km long Abulfeda Crater Chain (Catena Abulfeda) was probably formed by the impact of a disintegrating comet.

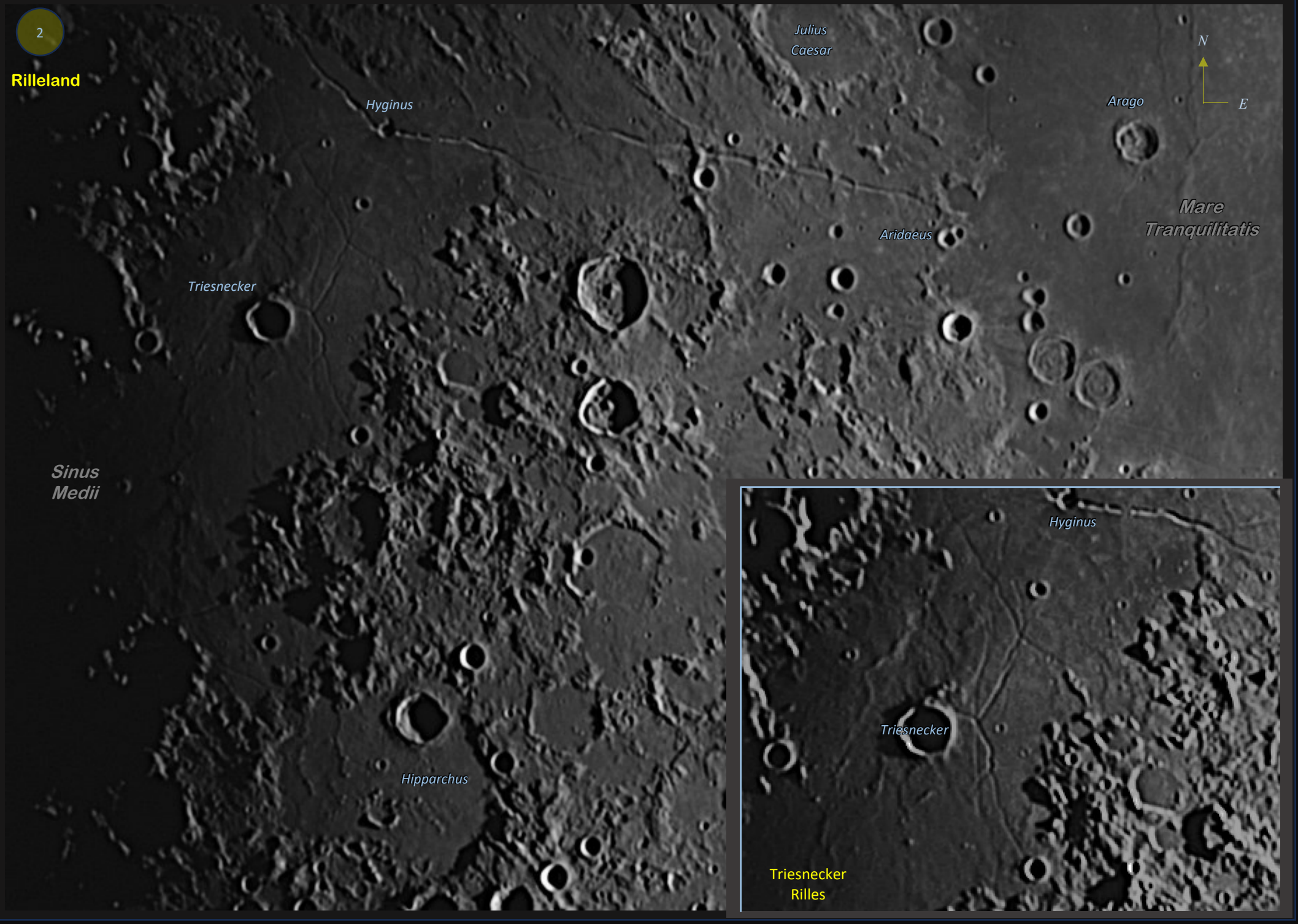
4 Mare Humboldtianum

The Moon Libration was: Latitude -0°55' and Longitude +5°17', meaning that the SE Quadrant was best exposed, but the NE quadrant with *Mare Humboldtianum* was also well seen.

On my image, I can clearly see the outer rim/scarp (*Andes Mts*., 650km Ø) of the *Humboldtianum Basin*, to the E of the flat floored *Endymion* crater, and further E I can follow the lower inner basin ring (the arcuate *Bishop Mts*., 340km Ø) around the small *Mare Humboldtianum* formed by dark lava covered with lighter ray material ejected by the Hayn impact.

It is thought that the inner rim is an enlarged central peak formed by lunar surface rebound, whereas the outer rim is the proper crater rim formed by collapse of excavated material into the transient impact excavation. The Mare inside Bishop Mts. is rather shallow, as the rim of a submerged crater can be seen protruding above the mare surface.


1
Haemus Mts.
Mare
Serenitatis
N
E
HAEMUS MTS.
L.Odii
L.Felicitatis
S. Fidei
L.Doloris
L, Gaudii
L.Hiemalis
L. Lenitatis
Mare
Vaporum
S. Honoris
Boscovich
Julius
Caesar
Hyginus

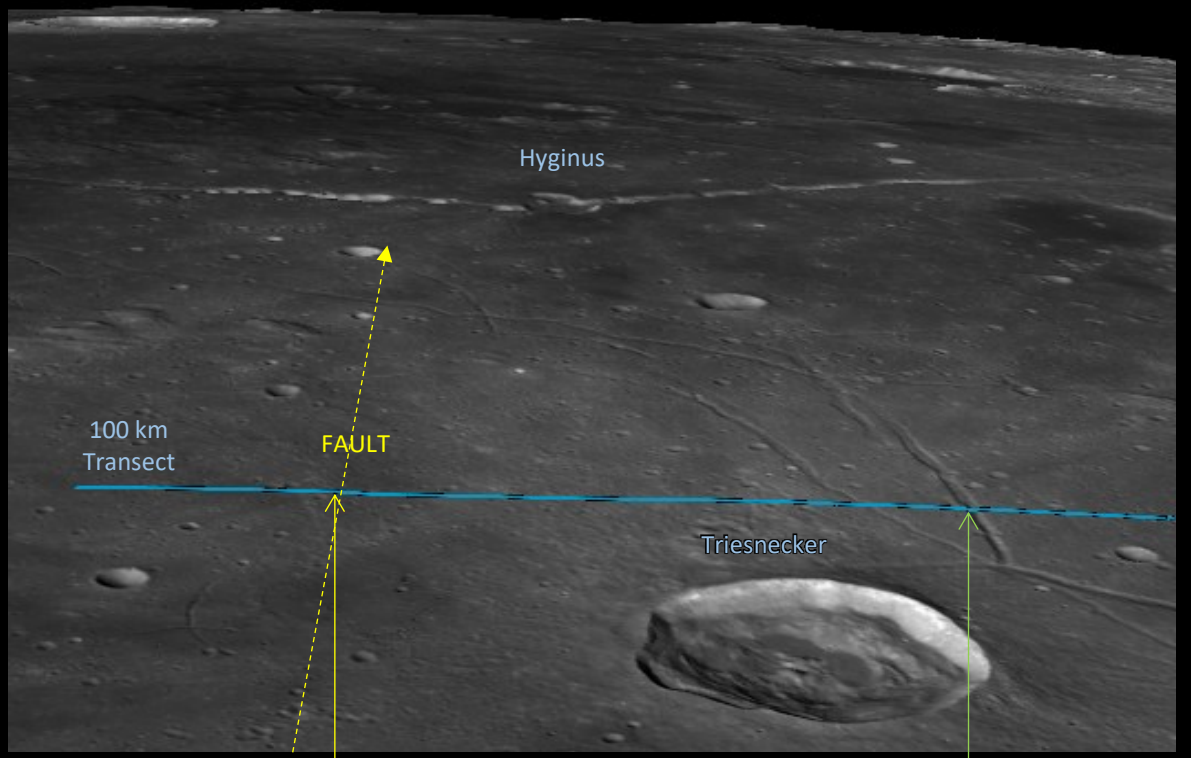

2
Rilleland
Julius
Caesar
N
E
Hyginus
Arago
Mare
Tranquilitatis
Aridaeus
Triesnecker
Sinus
Medii
Hipparchus
Hyginus
Triesnecker
Triesnecker
Rilles

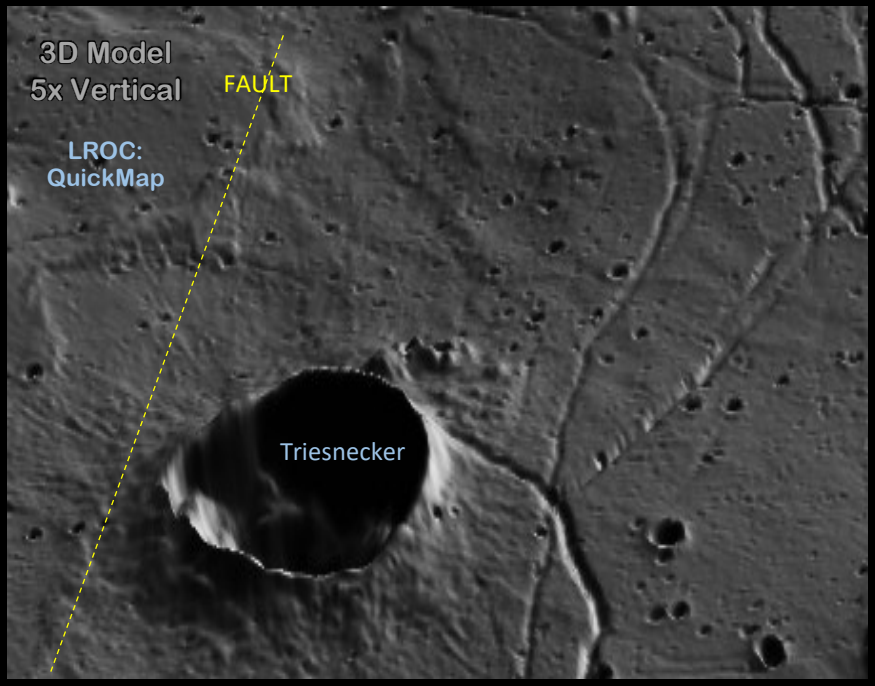
Triesnecker Region

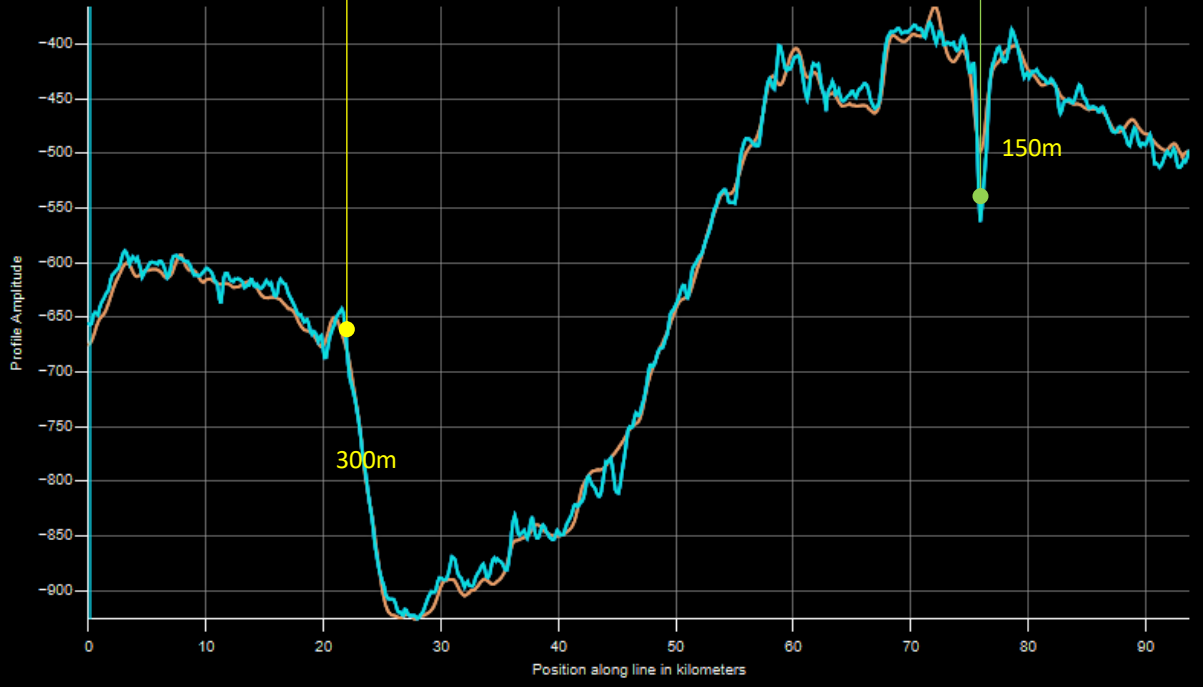
The geology (selenology) of this region is in fact not well understood, but I can discern some details from zooming in on the area using LROC :: Quickmap in 3D mode:

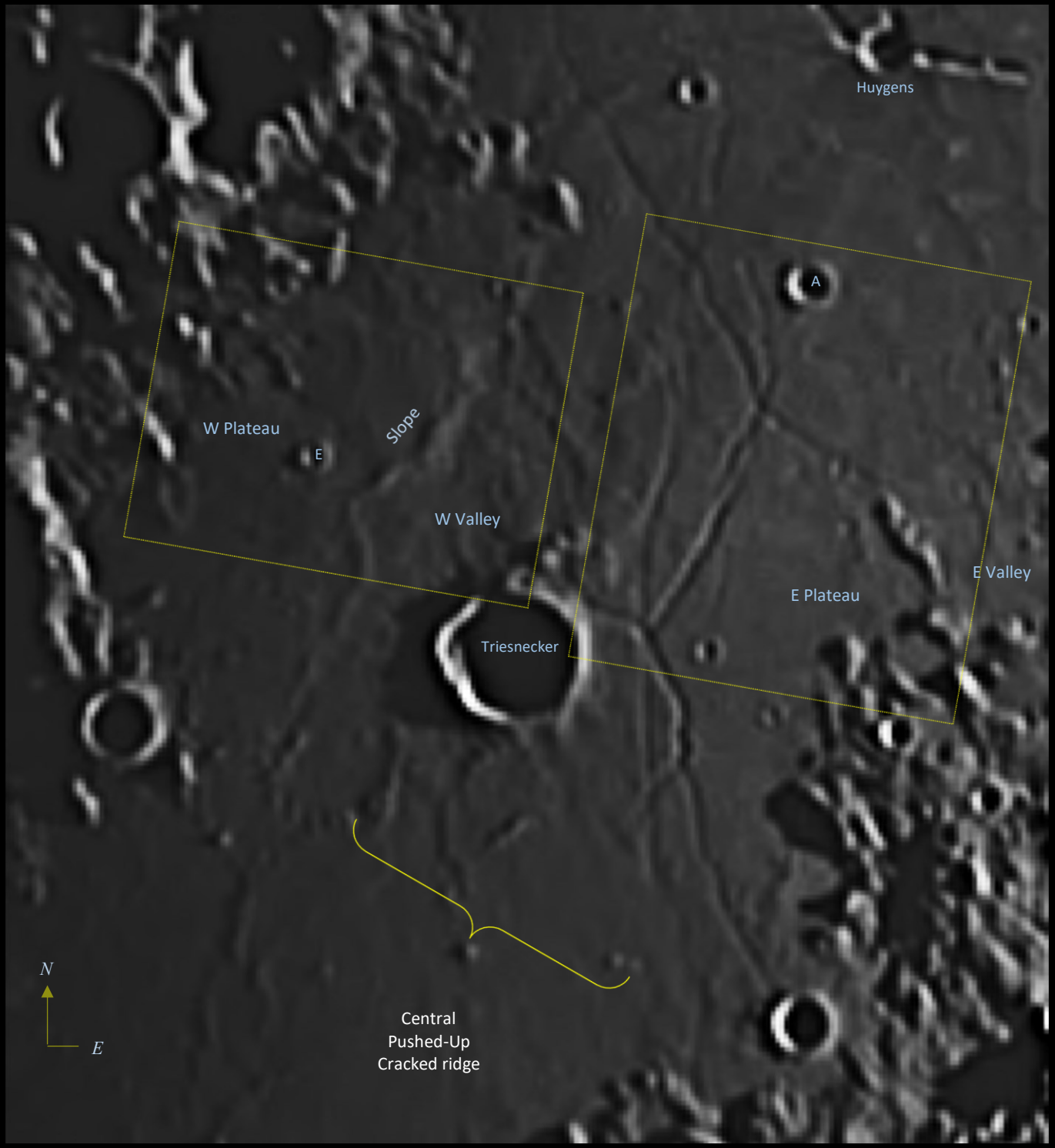
There's a ~50km long and 300m high fault line located ~20km W of Triesnecker crater, extending roughly in a SSW-NNE direction. The fault is evident on the 100km long E-W transect I made, where it looks dramatic due to vertical exaggeration of the graph, but in reality, it is a rather broad and shallow depression/valley covered by smooth ejecta from the Triesnecker crater. In fact, it looks like the Triesnecker crater is located on a long and broad uplifted lava ridge, maybe caused by magma upwelling from below; This could explain the Triesnecker rilles as primarily surface tension cracks.

The transect also crosses a couple of the linear Triesnecker rilles, which are seen to be narrow (~2km wide) with a depth ranging from 150m down to only 10-20m. It can be assumed that the shallow rilles are older and partly filled in by crater ejecta, while the deeper ones are younger. The origin of these rilles is still unclear, as they can be both tension cracks or dikes (i.e.: of volcanic origin).









Triesnecker

I've taken a closer look at my observation of the Triesnecker surroundings, using a couple of altimetric contour maps kindly provided to me by *John Robbins* ('Macpurity' here on CN).

The maps support (I think) my theory of an endogenic uprising of a broad ridge between the now eastern and western lowlands ('valleys') being at least a contributing cause to the cracking of the lava surface around the Triesnecker crater.

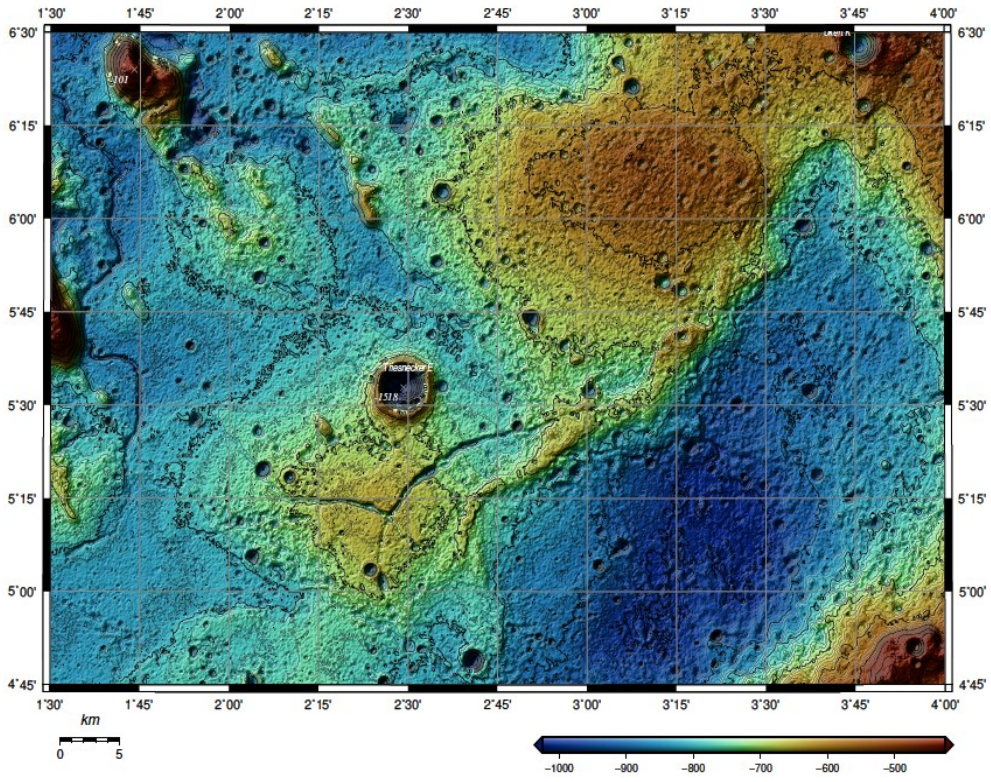
Arago Domes

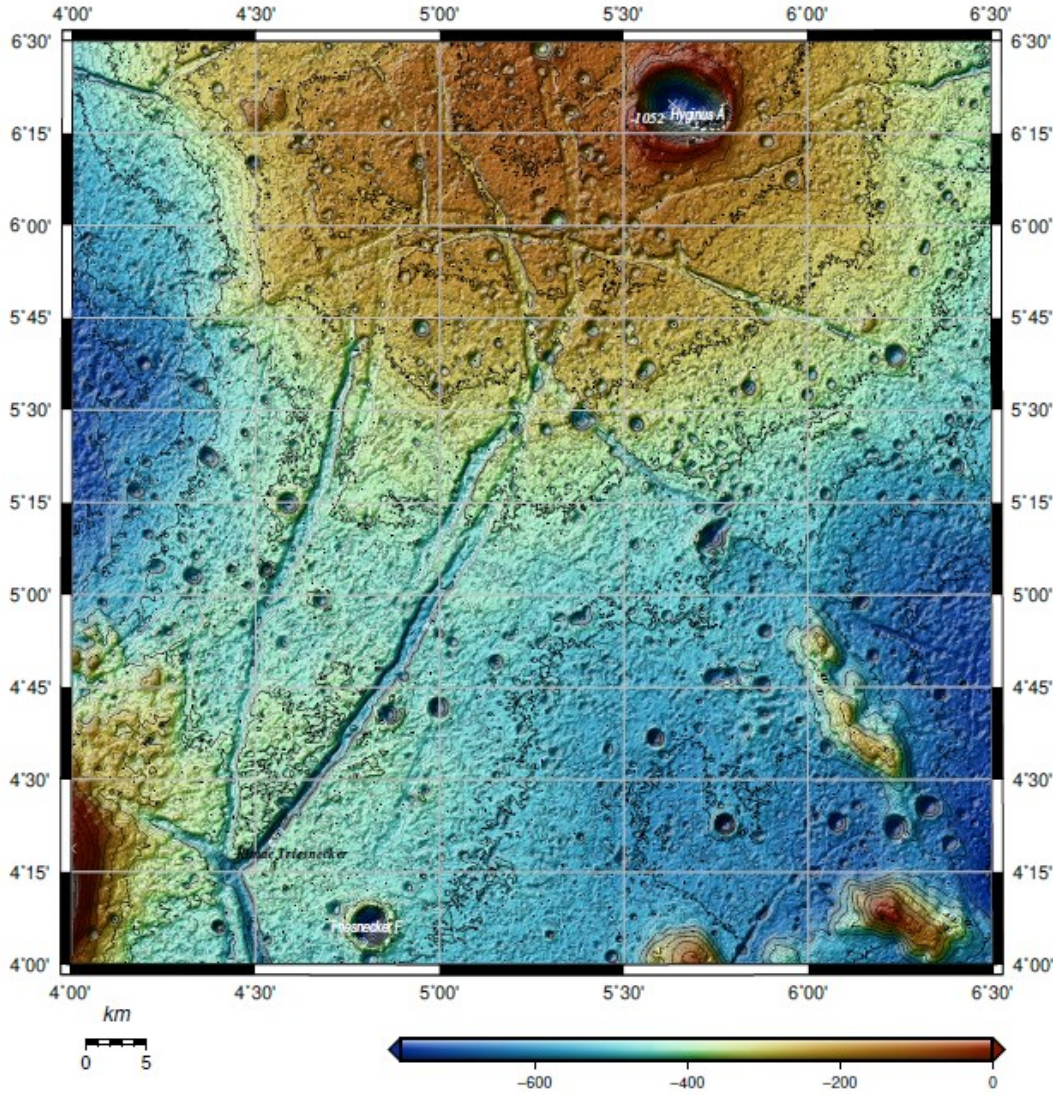
I also took a closer look at the Arago Domes (Arago α and β), located close to the Arago Crater.

The *Arago Crater* itself is ~26 Km wide, almost 2.2 km deep and with a steep (~15°) up to 400m high crater rim, where parts of the NW terraced inner wall have slumped down and inwards towards the central peak.

A pair of relatively large (15-20 km Ø) volcanic domes can be seen: one (β) west and one (α) north of the Arago crater; They are rugged lava piles formed as 'shield volcanoes', both reaching up ~200m above the surrounding terrain.

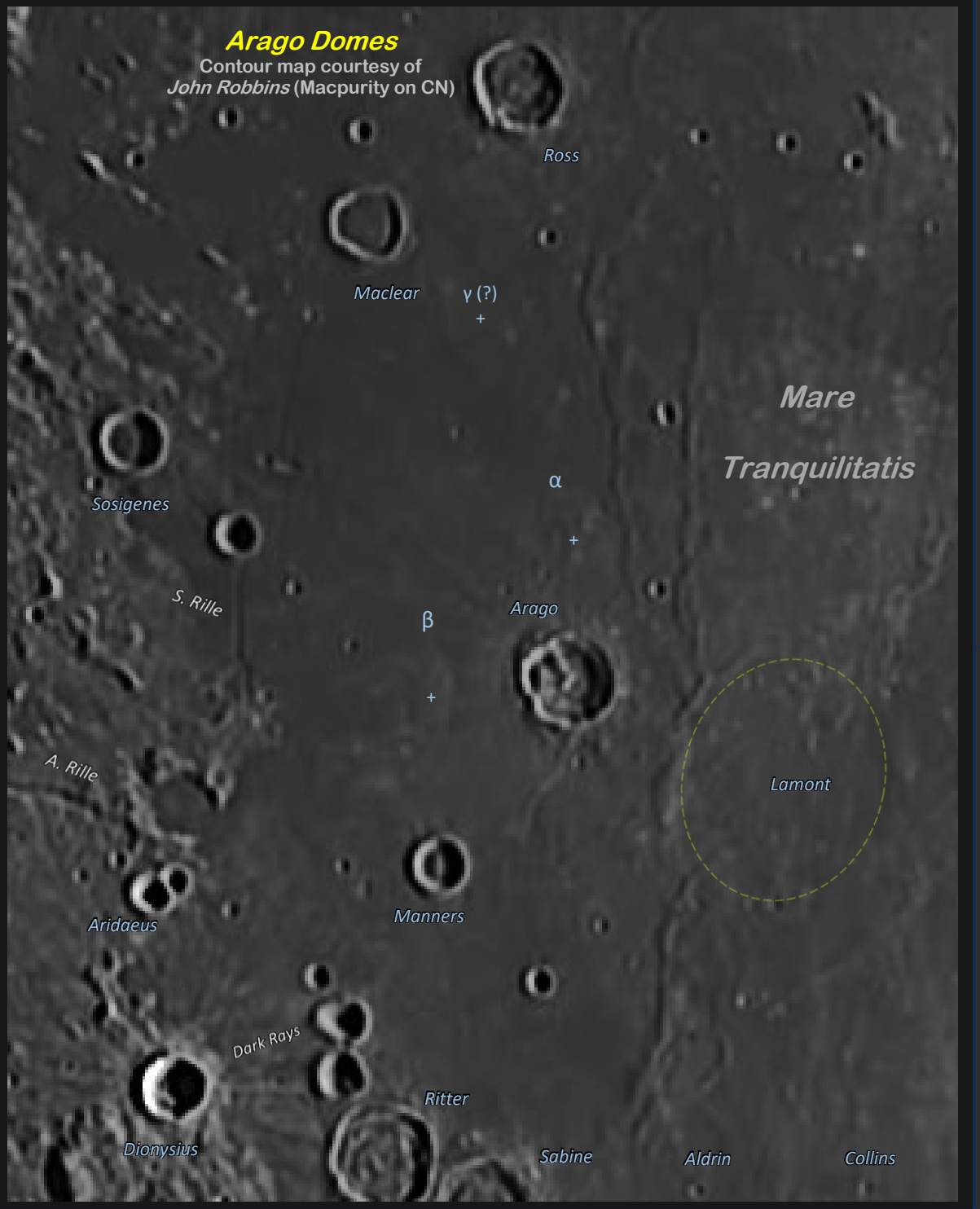
Both Arago Domes are located on a sloping terrain that rises up towards the W (slope ~1°); The E sides of the domes are therefore steeper (slope ~3°). Both domes have a flat top with two peaks; The peaks of Arago β are ~8 km apart, and a small lava channel (rille) seems to be running down the N slope (?) and turning west from the dome; The Arago α 'twin peaks' are only 2 km apart, with a depression between them, sloping down NE.

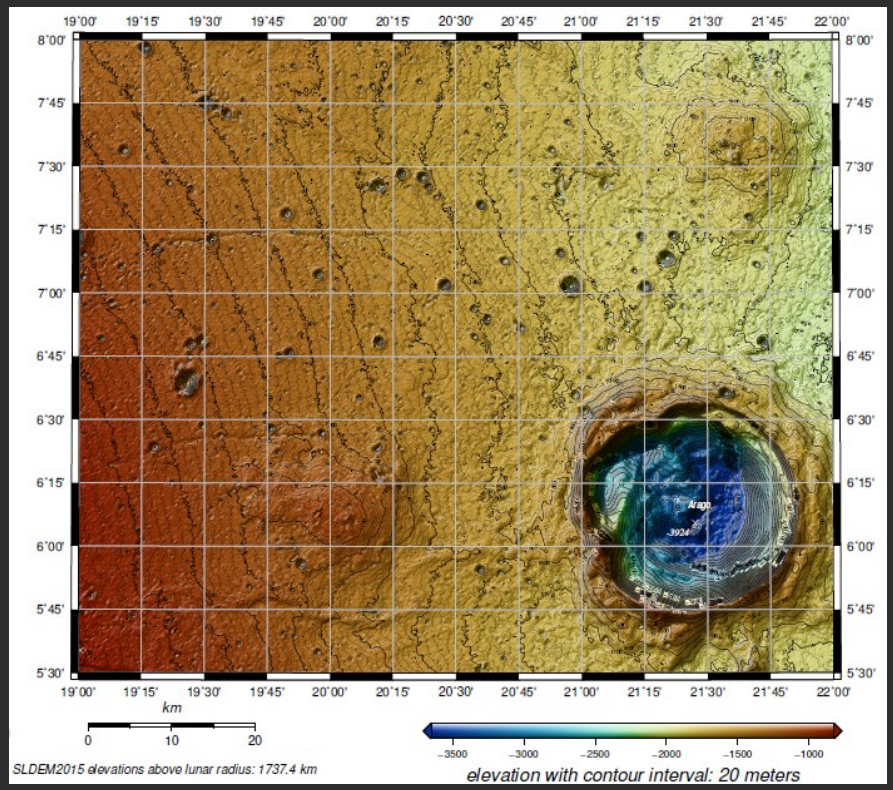


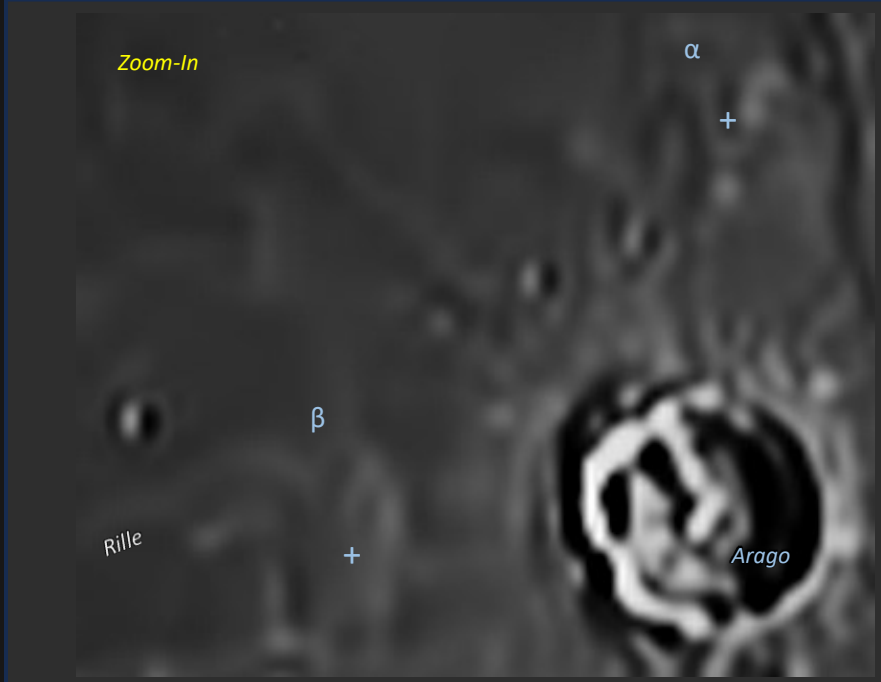


Lunar map from detailed SLDEM2015

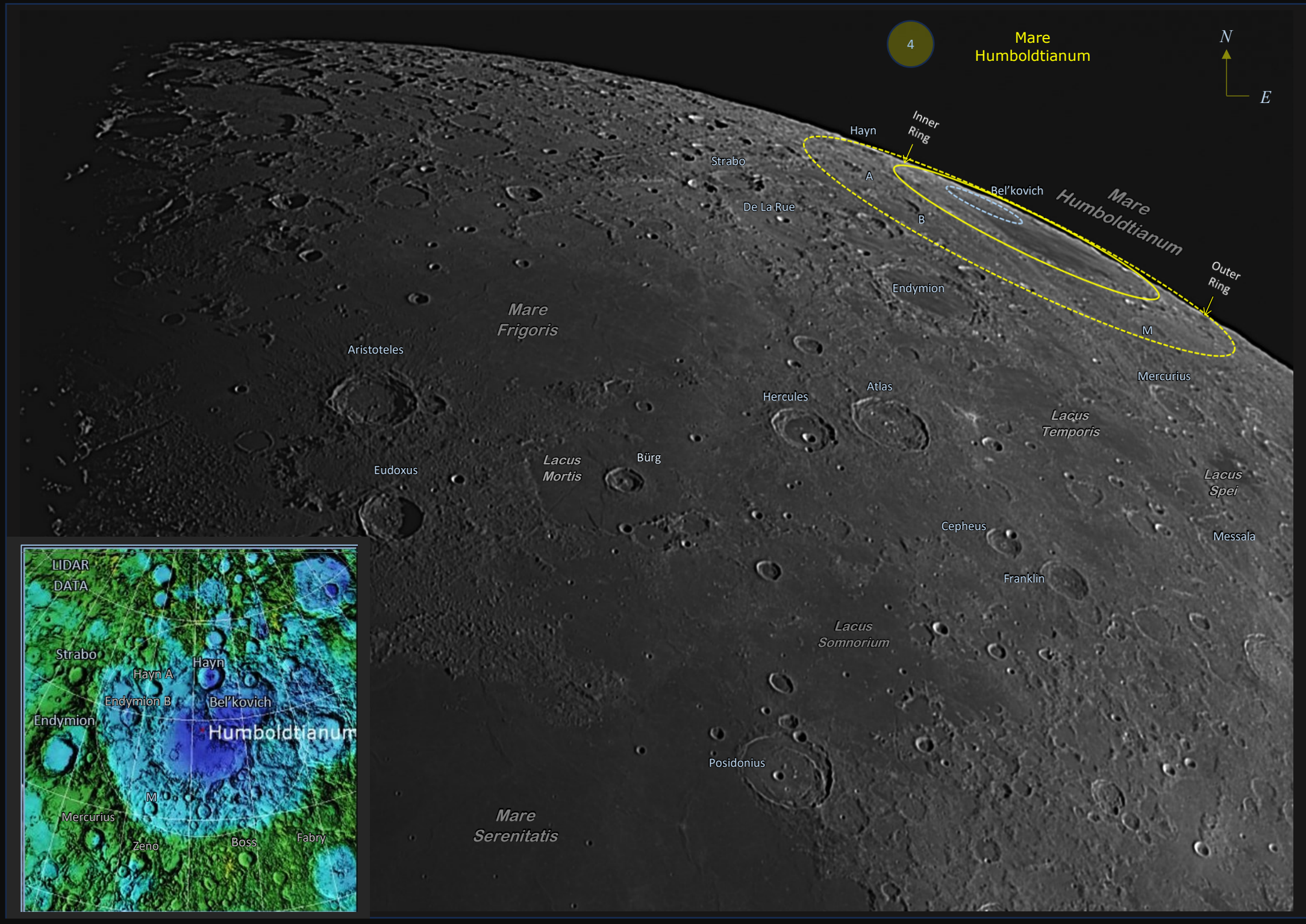
Maps courtesy of *John Robbins*
(Macpurity on CN)

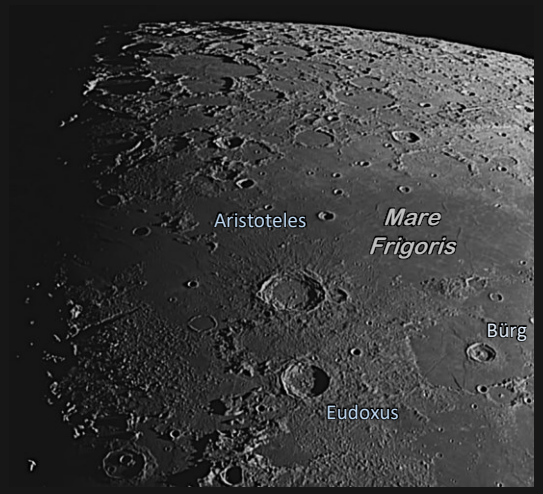

Arago Domes
Contour map courtesy of
John Robbins (Macpurity on CN)
Ross
Maclear
γ (?)
Mare
Tranquilitatis
α
Sosigenes
S. Rille
β
Arago
A. Rille
Lamont
Aridaeus
Manners
Dark Rays
Ritter
Dionysius
Sabine
Aldrin
Collins


km
0
10
20
SLDEM2015 elevations above lunar radius: 1737.4 km
elevation with contour interval: 20 meters


Zoom-In
α
β
Rille
Arago

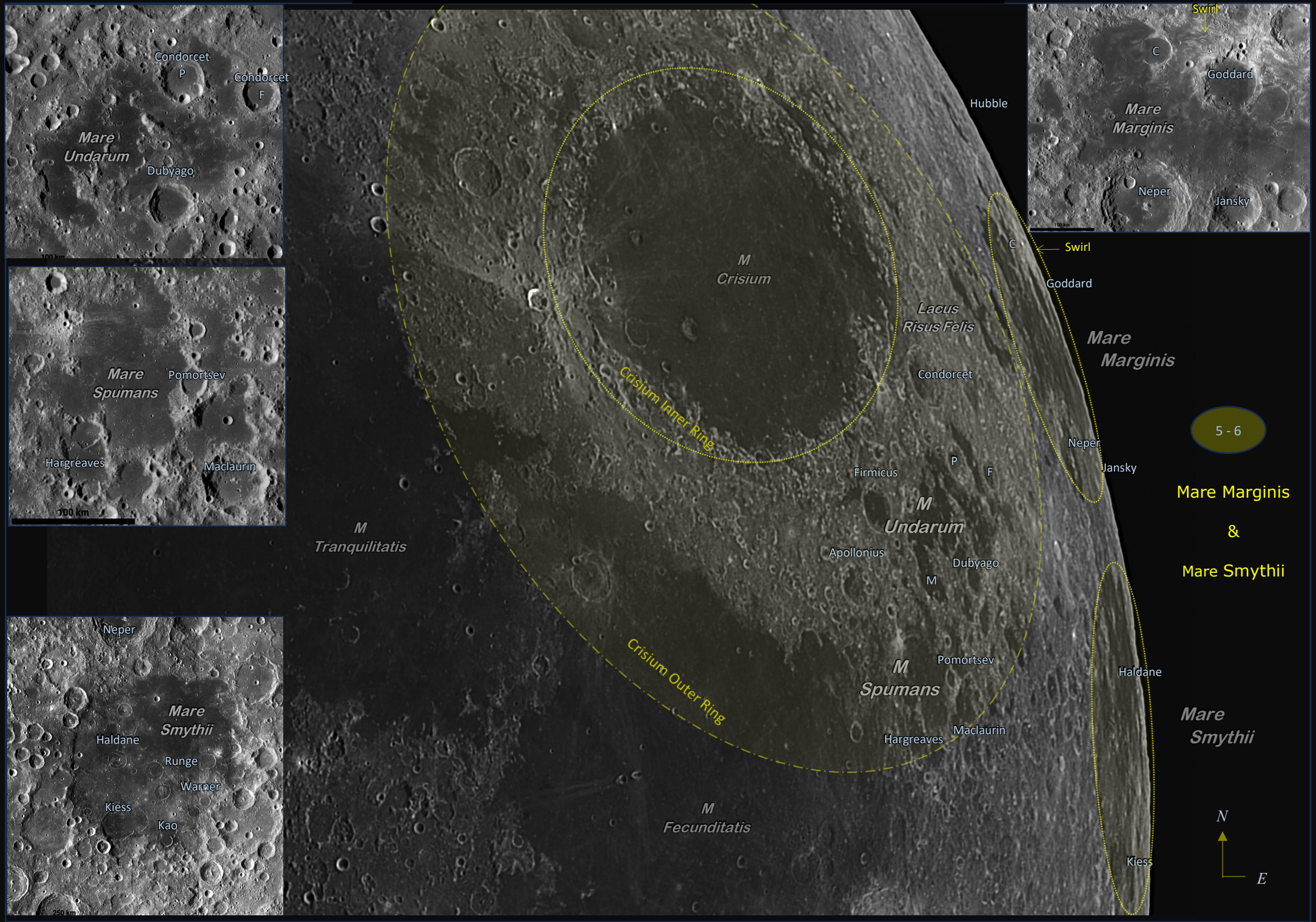

3
Central Highlands
Hipparchus
N
E
Albateginus
Klein
Caylay Plains
A16
SR
Smoky Mtn
Stone Mtn
Dollond
Descartes Mountains
Descartes
Abulfeda
Abulfeda crater chain
Geber
Sacrobosco
NORTH RAY
KIVA
SMOKY MOUNTAIN
APOLLO 16
EVA 3
PALMETTO
GATOR
FLAG
EVA 1
SPOOK
WRECK
EVA 2
BABY RAY
CINCO
2 km
SR
SOUTH RAY
STONE MOUNTAIN


4
Mare
Humboldtianum
N
E
Hayn
Inner
Ring
Strabo
A
Bel'kovich
De La Rue
B
Mare
Humboldtianum
Outer
Ring
Endymion
Mare
Frigoris
M
Aristoteles
Mercurius
Atlas
Hercules
Lacus
Temporis
Lacus
Mortis
Bürg
Eudoxus
Lacus
Spei
Cepheus
Messala
Franklin
Lacus
Somnorium
Posidonius
Mare
Serenitatis
LIDAR
DATA
Strabo
Hayn
Hayn A
Endymion B
Bel'kovich
Endymion
Humboldtianum
M
Mercurius
Zeno
Boss
Fabry

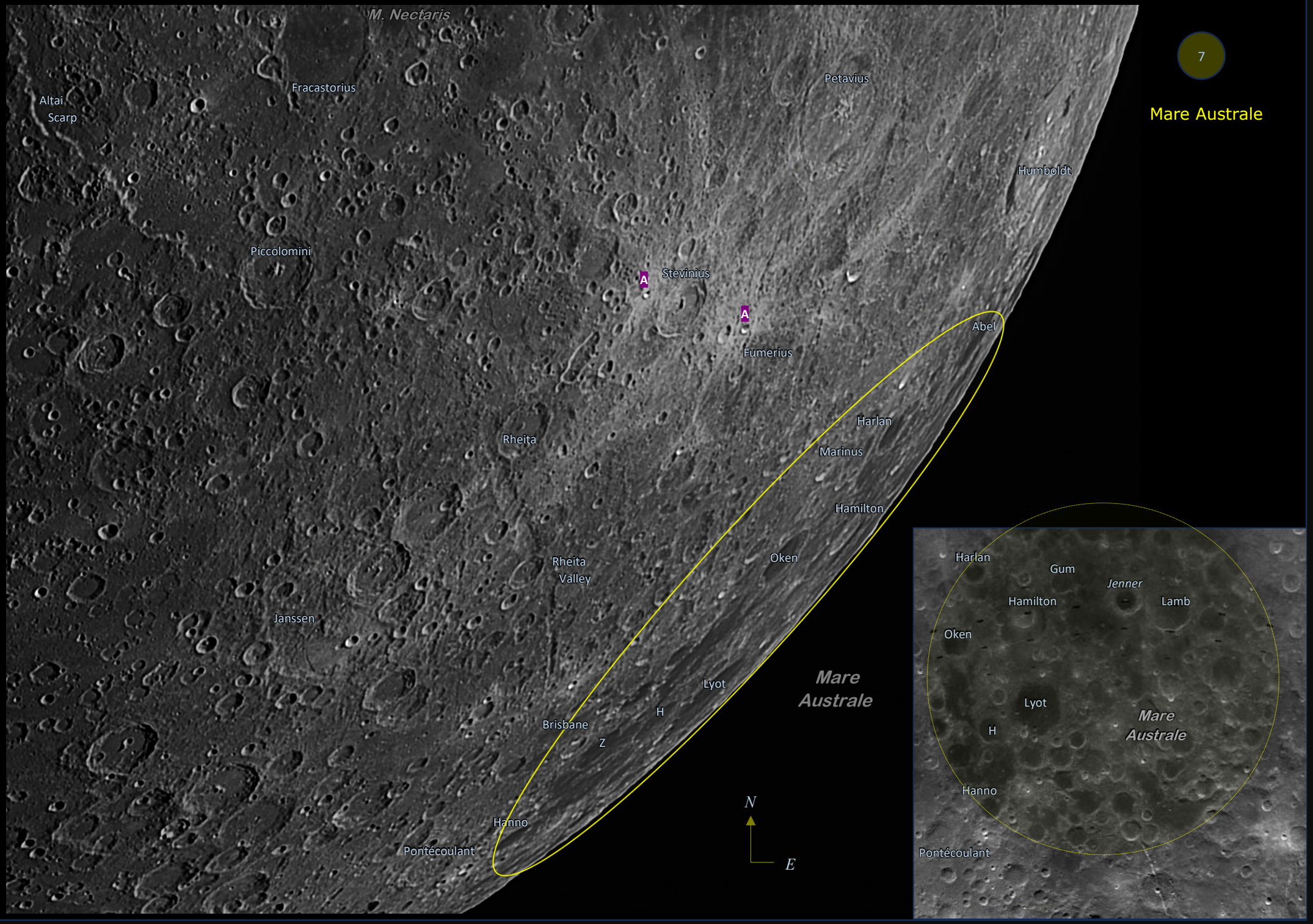


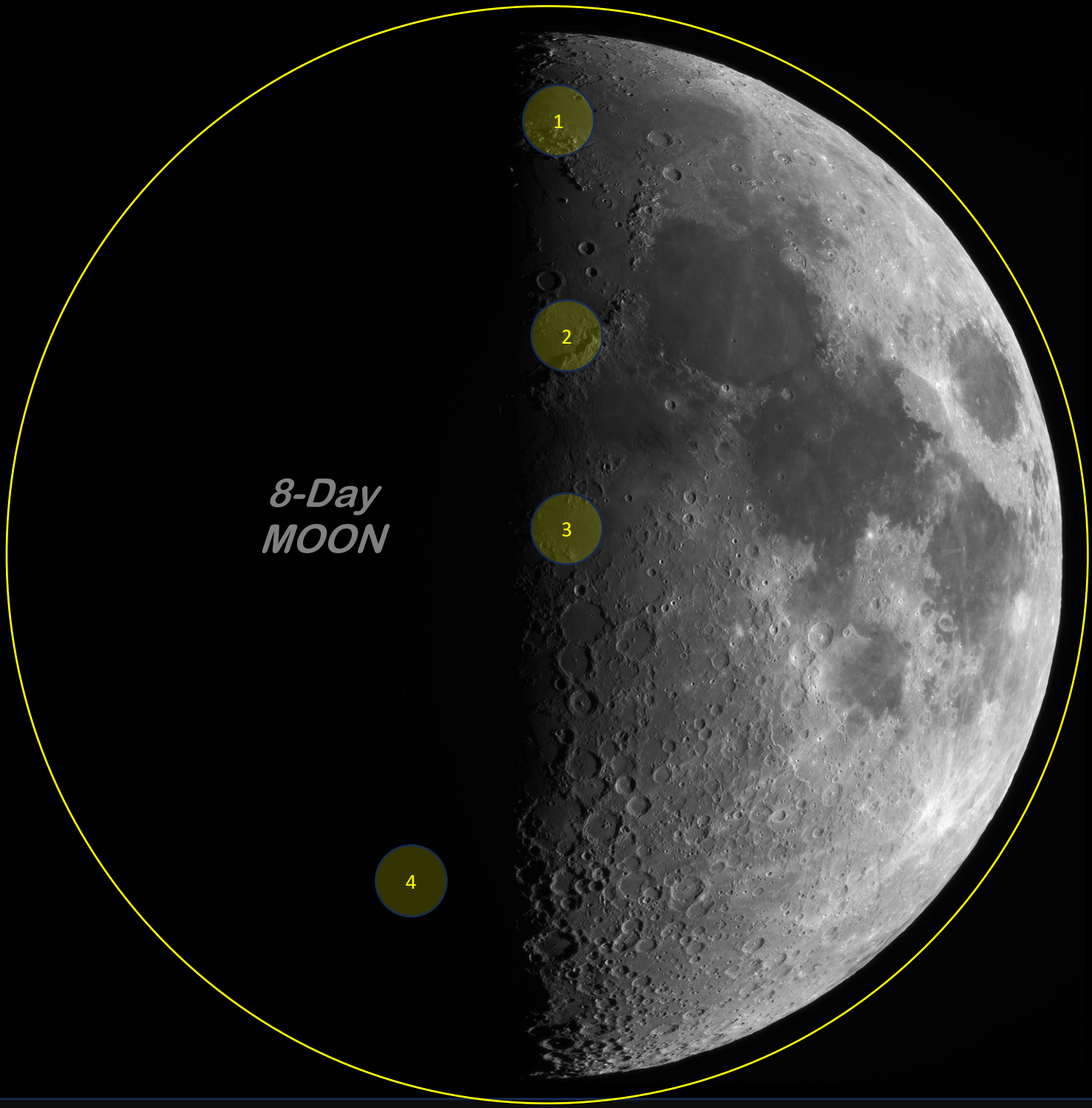
Aristoteles (87km Ø) and *Eudoxus* (67km Ø) are both large, young (Eratosthenian ~2 Byr) Tycho-type craters, but without compact central peaks; Instead, the rims show a combination of slumps and terraces, and the central area of each crater show a scattering of small hills.

The ejecta carpet of *Aristoteles* displays a strong radial pattern into Mare Frigoris, whereas that of *Eudoxus* is more evenly distributed. The floors of both craters seem to be flooded (like that of nearby Egede) by lava / magma having risen up through cracks in the impact bowl.


Condorcet
P
Condorcet
F
Mare
Undarum
Dubyago
100 km
Mare
Spumans
Pomortsev
Hargreaves
Maclaurin
100 km
Neper
Mare
Smythii
Haldane
Runge
Warner
Kiess
Kao
250 km
Swirl
C
Goddard
Mare
Marginis
Neper
Jansky
100 km
Hubble
M
Crisium
Crisium Inner Ring
Crisium Outer Ring
Lacus
Risus Felis
C
Swirl
Goddard
Mare
Marginis
Condorcet
Neper
Jansky
Firmicus
P
F
M
Undarum
Apollonius
Dubyago
M
M
Tranquilitatis
M
Spumans
Pomortsev
Haldane
Hargreaves
Maclaurin
Mare
Smythii
M
Fecunditatis
Kiess
N
E
5 - 6
Mare Marginis
&
Mare Smythii


Lacus Somnorium
Geminus
Hall
G Bond Rille
Burckhardt
G. Bond
Posidonius
Newcomb
Serpentine Ridge
Taurus Mountains
Cleomedes
Le Monnier
Römer
Lacus Bonitatis
Aldrovandi Ridge
Macrobius
M Serenitatis
Littrow
Taurus-Littrow Valley
Sinus Amoris
A17
Lister Ridge
Maraldi
Vitruvius
Proclus


M. Nectaris
Altai
Scarp
Fracastorius
Petavius
Humboldt
Piccolomini
Stevinius
A
A
Abel
Fumerius
Harlan
Marinus
Rheita
Hamilton
Rheita
Valley
Oken
Janssen
Lyot
Mare
Australe
H
Brisbane
Z
Hanno
Pontécoulant
N
E
7
Mare Australe
Harlan
Gum
Jenner
Hamilton
Lamb
Oken
Lyot
H
Mare
Australe
Hanno
Pontécoulant


8-Day
MOON
1
2
3
4

The 8-Day waxing half-moon.

It's the **beginning of March** (20202-03-02, 19:30 local CEST, UT+1), and the Moon is sailing high up at 47° altitude in *Taurus* towards the SSW. There's spray of high cirrus and a surf of lower Cirrus radiatus on the celestial ocean tonight, but Orion and the Moon can be seen in the "shallows" between the clouds. I'm out in the astronomical twilight in my suburban backyard (NELM 5.8) in this cool 4°C spring evening, with the usual high humidity of the season (93%) and with the dewpoint at our heels ~3°C.

The **lunation is 8 days (50%)** and the libration is [+3° Lat, -8° Long] meaning that the lunar backside is best studied at the NW rim, which is not favorable for tonight's half-moon; Never the less, I plan to make a **sweep down the terminator**, focusing on the features that were not easily studied at last night's 7-Day moon (where I was also out observing the Moon).

The sweep tonight will take me from the northern region around *Aristoteles*, past the *Apennine Bench* at the E shore of Imbrium, down into the *"Rille Land"* around Sinus Medii and to the southern *"Cratered Highlands"* from the Deslandres to the Maginus region.

1 Aristoteles Area

I start my sweep from the north, centering the large crater *Aristoteles* in my field of view. The northern highland shows the degraded remains of several large ancient **pre-Nectarian craters** (*Goldschmidt, W. Bond, Meton, Baillaud, De La Rue, Endymion),* and right at the N rim, the large craters **Nansen and Hayn** can be seen in profile; *Nansen* is a 123 Km Ø and 3 Km deep excavation with a 1 Km high crater wall rising above the surroundings, while *Hayn* is a 88 Km Ø crater with a 2 Km high E crater wall, that falls in a ridge down 4 Km to the level of *Mare Humboldtianum*.

At the N shore of Mare Frigoris is seen a pair of younger craters: the **Imbrian Sheepshanks** and the **Eratosthenian Archytas**. Both of these have a close by rille: *The Rima Sheepshanks* is a narrow E-W running rille that is difficult to see (I can't spot it with certainty tonight), while *Rima Archytas* is broader and easier to observe along the southern shore of Mare Frigoris (N of Vallis Alpes). Both of these rilles seem to be shallow grabens/dikes created by tension as fissures in the lava sheets along the Mare shores. Another type of rille is the sinuous rilles of volcanic origin (lava channels), such as *Rima Calippus* seen at the NW shore of Mare Serenitatis in my image below.

Dominating the view are of course the large and young craters **Aristoteles** (Eratosthenian) and **Eudoxus** (Copernican). Aristoteles has thrown out a ring of impact melt and a large ejecta carpet of hillocky crust material in radial ridges, grooves and chains of secondary craters fanning up N into Mare Frigoris. S of Aristoteles, the younger Eudoxus impact has draped the area in its own ejecta carpet. The floors of both Aristoteles and Eudoxus are flat with small central peaks, suggesting a late lava flooding from uprising magma.

2a Apennine Bench - Overview

Sweeping the field of view now down south along the terminator, I place *Serenitatis* towards the E and the region around *Archimedes* towards the W. I observed the Serenitatis basin at the 7-Day Moon, so tonight I'll concentrate on the formations around *Archimedes*, also known as the **Apennine Bench**.

W of Serenitatis, the **Apennine Mountains** rise up gradually to a height of 5 Km, then falls down in a steep scarp to the level of Mare Imbrium. This spectacular arcuate mountain range is the rim of the young Imbrium Basin excavation, which has warped up the surrounding crust, and then coated it with a large ejecta carpet that can be seen tapering off down towards the SE, in wedges of hummocky hilly backslope terrain, furrowed by radial linear grooves, ridges and catenae, -- all known as the **"Imbrium Sculpture"**.

During the Imbrium impact (3.85 Byr), the W side of the **Apennine Basin** rim slid down in large slump terraces and landslide blocks towards the center of the excavation, then at the impact rebound, the E part of the basin floor was uplifted, including impact melts and landslides from the basin rim. Later in the Imbrian epoch, craters were formed on the basin floor (such as *Cassini* and *Archimedes*), and uprising mantle magma further uplifted the area and erupted, creating igneous rocks on the basin floor (3.84 Byr old KREEP lava).

During the upper Imbrian great lava flood, the uplifted parts of the basin floor (including craters, slump terraces and landslides) were only partly embayed by mare basalts. The light-hued rough landscape of uplifted and down-sliding crust material is what we observe today as the interesting **Apennine Bench Formation** (ABF). As icing on the cake, there are also sprinkles of young Copernican craters (such as *Aristillus* and *Autolycus*) on top on the mare surface.

In my observation -- and looking at the image below --, I can see the top of the inner Imbrium basin ring: *Spitzbergen Mts*., and of course the steep excavation boundary rim: the *Apennine Mt.* front, with its land slump blocks, terraces and arcuate lava **stretch marks / grabens**: *Rimae Bradley, Fresnel, Theaetetus*. Also well seen at the 8-Day Moon is the slightly younger uplifted Apennine Bench with its radial stretch marks: *Rimae Aristarchus* plus a couple of volcanic domes: *Pu1, Au* in Palus Putredinis.

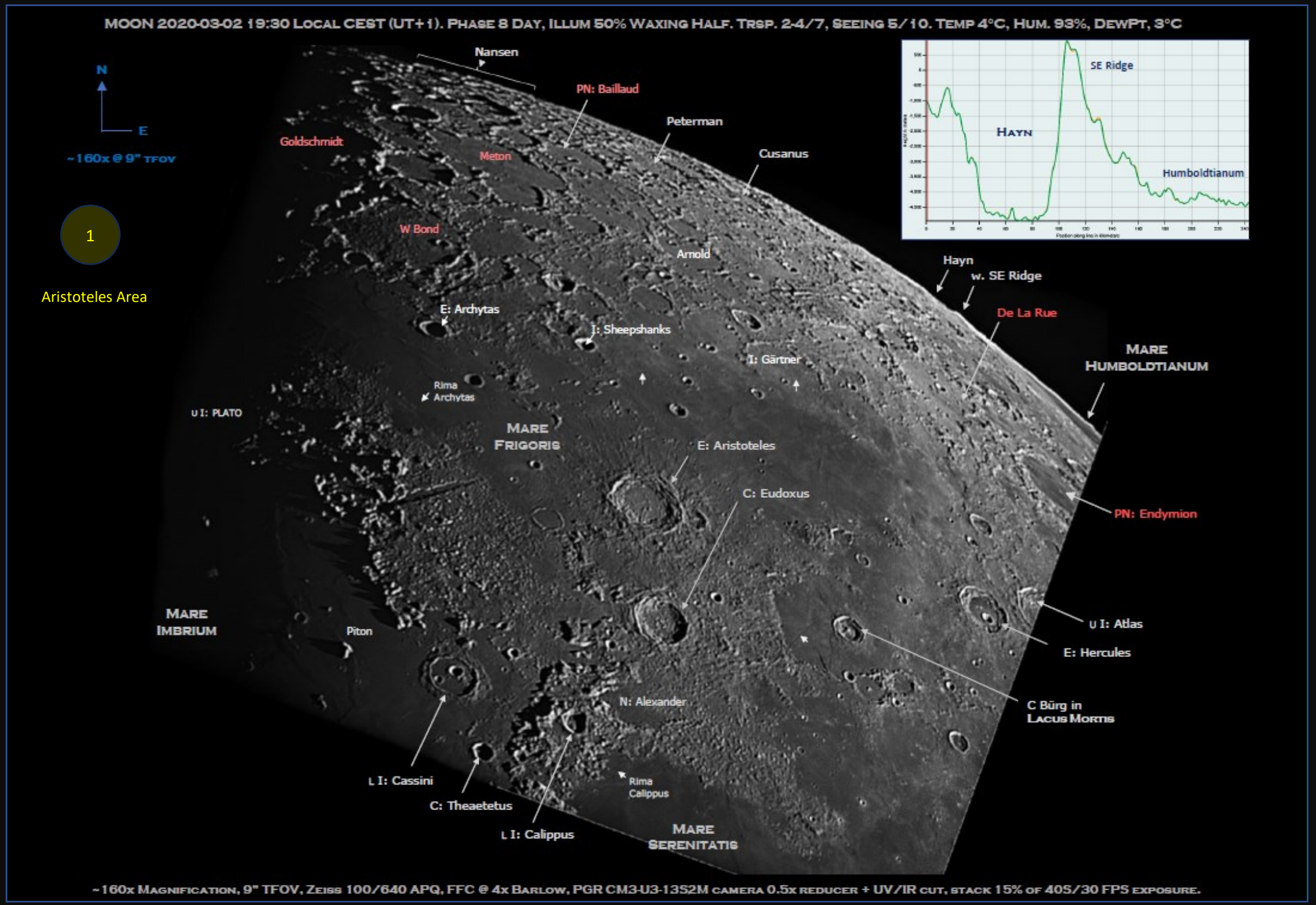
A special site of interest is the **volcanic sinuous rille** *Rima Hadley*, which is the probable outlet of the magma that has covered Palus Putredinis. Similar sinuous rilles are *Rima Conon* that has fed into Mare Vaporum and *Rima Calippus* at the NW "corner" of Mare Serenitatis.

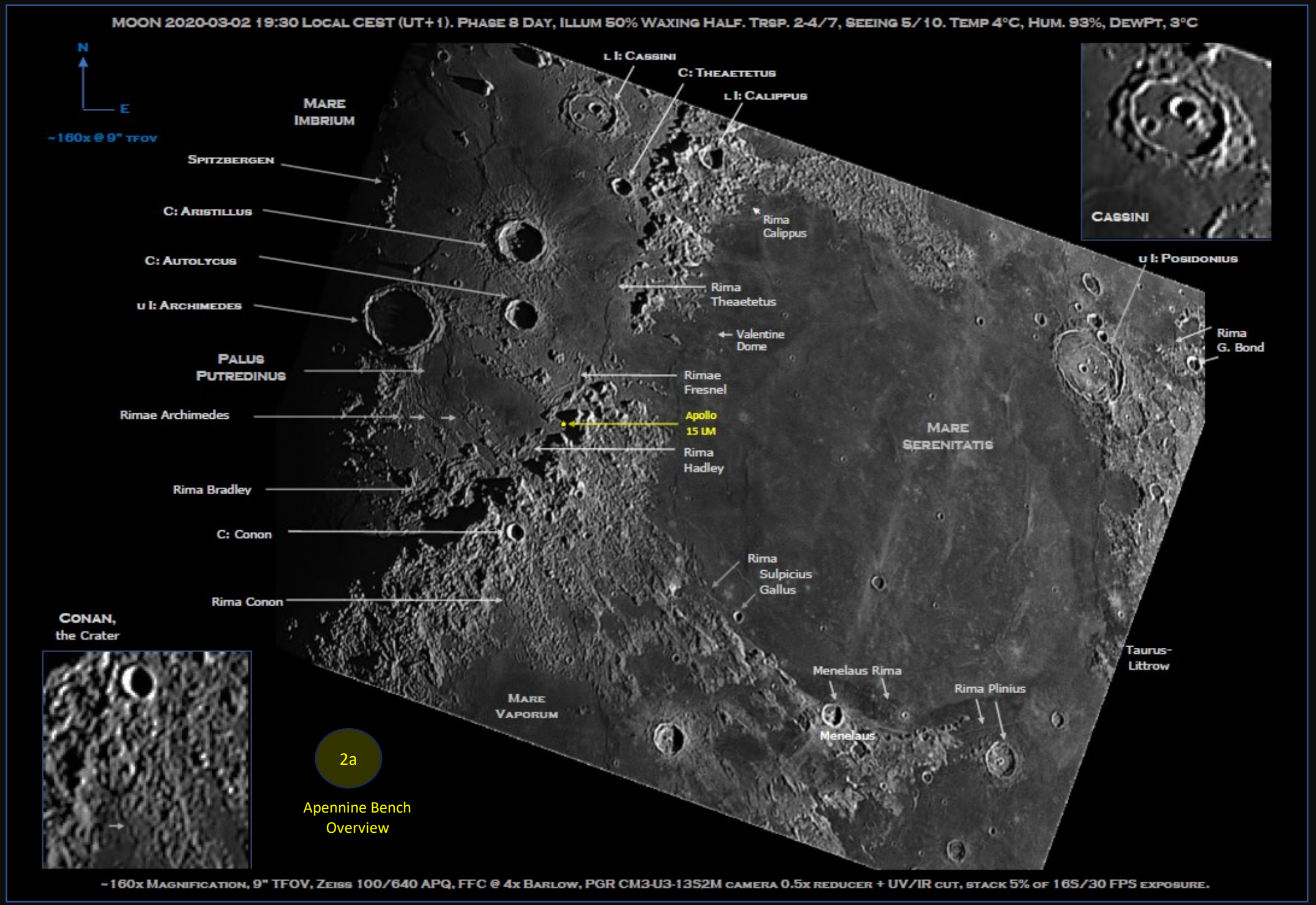
2b Apennine Bench - Apollo 15

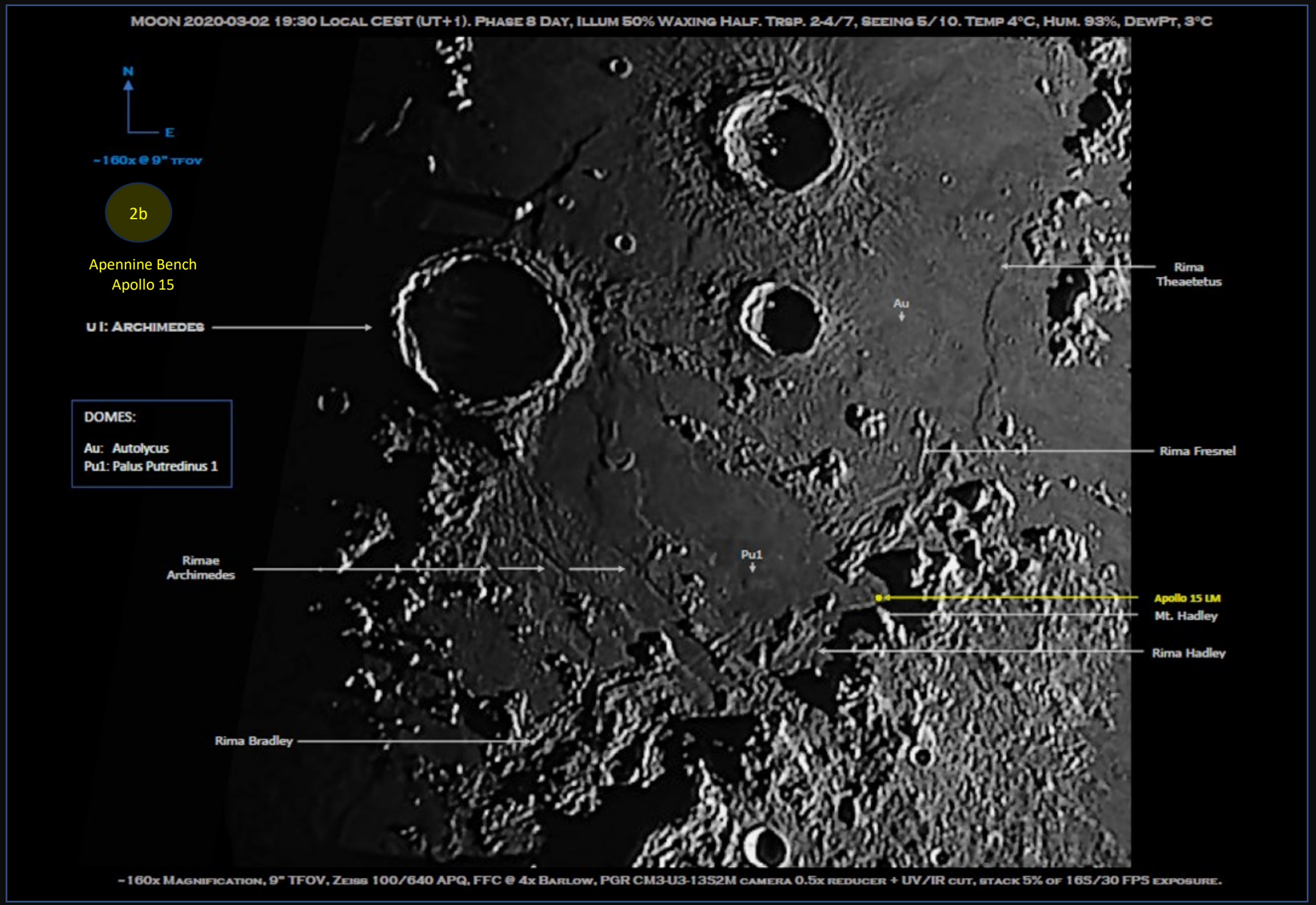
Our knowledge of the **Apennine Bench geology** mostly stems from the **Apollo 15 mission** to the valley N of *Mt. Hadley*. The location of this mission was chosen in the hope of sampling mare material from *Palus Putredinis*, while also investigating any mare stratification in the Hadley sinuous rille and sampling exposed old lunar terra crust below Serenitatis ejecta in the up-warped Apennine Mt. scarp. The Astronauts *James Irvin and David Scott* had received a substantial training in geology including many days of field work on Earth.

On 1971-07-26 13:34 GMT Irvin and Scott touched down with the **"Falcon" LM north of Mt. Hadley**, in a hummocky terrain close to the "elbow", where Rima Hadley bends sharply from a direction ENE-> up NNW. The lunation was ~8½ days so the valley was well lit without the long shadows from the Apennine Scarp seen at an 8-Day moon.

Using the lunar rover, they were able in the following days to perform 3 EVAs, laying down a track 28 Km long. At Rima Hadley they confirmed that it had formed as a lava channel with overflowing levees of magma that they could inspect as layered outcropping ledges in the walls of the rille; Later, driving 1 Km up a steep slope in the foothills of the Apennine front, they were able to collect composite white/black breccia rocks composed of light hued crystalline anorthosite of igneous origin (original lunar crust) with dark KREEP-rich inclusions (Imbrium impact melt). The Apollo 15 samples were used back on Earth to date the formation of lunar terrae and maria, showing the lunar crust age to be ~4.5-4.1 Byr, the Imbrium Basin age 3.86 Byr, the Apennine Bench KREEP terra-type volcanic plains 3.85 Byr and Palus Putredinis mare flooding age 3.3 Byr. Way to go!


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
1
Aristoteles Area
Nansen
PN: Baillaud
Peterman
Cusanus
Goldschmidt
Meton
W Bond
Arnold
Hayn
w. SE Ridge
De La Rue
E: Archytas
I: Sheepshanks
I: Gärtner
MARE HUMBOLDTIANUM
Rima Archytas
u I: PLATO
MARE FRIGORIS
E: Aristoteles
C: Eudoxus
PN: Endymion
MARE IMBRIUM
Piton
u I: Atlas
E: Hercules
N: Alexander
C Bürg in LACUS MORTIS
L I: Cassini
C: Theaetetus
Rima Calippus
L I: Calippus
MARE SERENITATIS
SE Ridge
HAYN
Humboldtianum
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 15% OF 405/30 FPS EXPOSURE.


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
MARE IMBRIUM
L I: CASSINI
C: THEAETETUS
L I: CALIPPUS
SPITZBERGEN
C: ARISTILLUS
C: AUTOLYCUS
U I: ARCHIMEDES
PALUS PUTREDINUS
Rimae Archimedes
Rima Bradley
C: Conon
Rima Conon
Rima Calippus
Rima Theaetetus
Valentine Dome
Rimae Fresnel
Apollo 15 LM
Rima Hadley
MARE SERENITATIS
U I: POSIDONIUS
Rima G. Bond
Rima Sulpicius Gallus
Menelaus Rima
Rima Plinius
Menelaus
MARE VAPORUM
Taurus-Littrow
CASSINI
CONAN, the Crater
2a
Apennine Bench Overview
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 5% OF 16S/30 FPS EXPOSURE.


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
2b
Apennine Bench
Apollo 15
U I: ARCHIMEDES
DOMES:
Au: Autolycus
Pu1: Palus Putredinus 1
Au
Rima Theaetetus
Rima Fresnel
Rimae Archimedes
Pu1
Apollo 15 LM
Mt. Hadley
Rima Hadley
Rima Bradley
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 5% OF 165/30 FPS EXPOSURE.

E Imbrium, Apollo 15

It's a fresh and windy early evening in mid-January (2019-01-14, 19:00 Loc. CEST, UT+1). We're experiencing the third low pressure from NW here in January, now sweeping across Denmark with stormy winds, so the start of this year has certainly not offered the best conditions for astronomical observations; -- but the half-moon is now sailing high up at 46° in *Taurus* close to the meridian, and after some weeks with rain and overcast skies, I now seize the opportunity to have a look at our satellite.

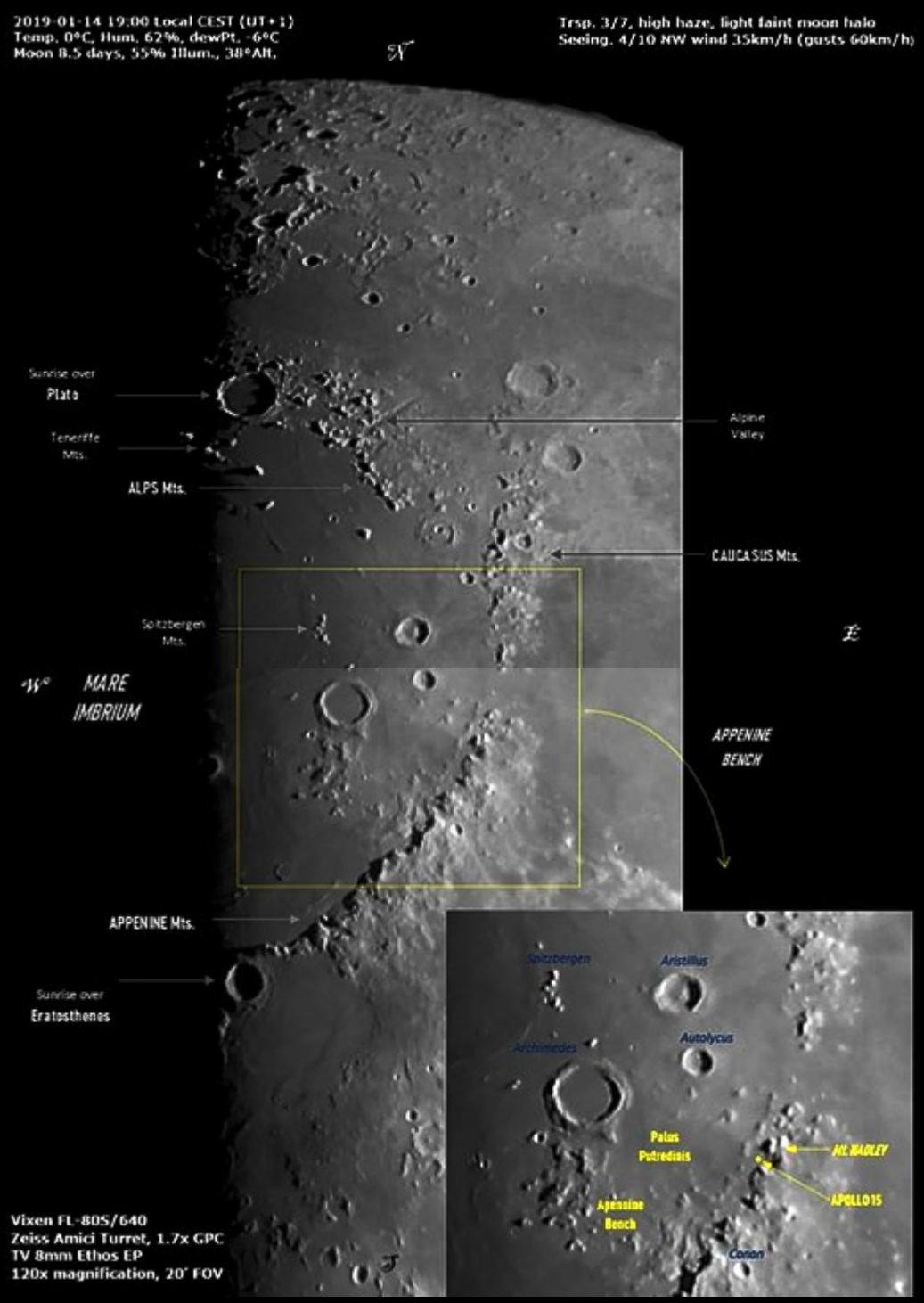
I mount my trusty classic Vixen FL-80S/640mm refractor on a sturdy Zeiss-Ib EQ tripod, and though both transparency and seeing tonight are well below medium, and strong winds are huffing and puffing at my OTA, observation is still quite satisfactory, in between the wavering seeing and gusting wind.

I load a TV 8mm Ethos in the turret, yielding a mag. of 120x in a good 25' FOV. I settle on the eastern Mare Imbrium region as my target, focusing on the area SE of Archimedes, which held enough interest from a Lunar geological point of view to be selected as landing site for the Apollo 15 mission. The terminator tonight is located in a line just W of Plato down to Eratosthenes, with beautiful shadows from the E rim of these craters flooding half of the crater floors; To the SE of Eratosthenes are seen some of the DMDs (Dark Mantle Deposits) that were created by volcanic activity in the wake of the Imbrium crater impact.

The landing site for Apollo 15 was selected to be on the lava flows of Palus Putredinis at the W base of Mt. Hadley in the Apennine Mt. range, close to a 1km wide lava channel (the Hadley Rille), -- which I however am not able to spot tonight. Apollo 15 returned samples of impact-shocked rock and lavas from the site, that made it possible to date the formation of the Imbrium basin as well as the mare lavas.

The W side of the Apennines rise up steeply to 5 km high scarps, then slopes down towards the SE. The mountain range was created when Lunar crust at the edge of the Imbrium basin was warped up by the impact, and then coated by an ejection blanket excavated down to 60 km depth. To the W of the Apennine scarps, landslide blocks have slid down from the basin rim and formed slump terraces. The Spitzbergen mountains and the light hued hilly terrain S of Archimedes (the Apennine Bench) are old igneous rocks erupted 3.8 Byr ago shortly after the Imbrium impact.

Later, around 3.3 Byr ago, radioactive heating in the Lunar mantle generated the lavas that flooded the Imbrium basin, apart from high crater rims (like Archimedes), the top of some igneous rock formations on the crater floor (like Spitzbergen and the Apennine Bench) plus terraces at the basin rim now protruding as thin ridges and rocky crests.



(The 8-Day Moon)

3 "Rille land"

Forming a large arc **outside the Apennine Front** of the Imbrium basin rim is an area with many **old battered craters** (including the pre-Nectarian: *Murchison, Oppolzer, Flammarion, Reaumur, Hipparchus, Ptolemaeus* and *Julius Caesar*); These were heavily draped in NW->SE radially oriented ridges of debris, when the Imbrium impact blasted out a giant **ejecta carpet**. Later (in the upper Imbrian and Eratosthenian epochs) the low trough outside the up-warped Apennine rim was partly flooded with **lava** that formed the shallow ponds of *Mare Vaporum, Sinus Medii* and *Sinus Aestuum*, and as these small lava lakes filled up and solidified, different types of erosion, tension and sag formed **rilles** ("rimae") in the lava, today seen as sinuous lava channels, straight stretch marks (grabens/dikes) and irregular surface fractures caused by magma uplifting.

The "**Rilleland**" is rich on examples of such features, from the subsidence cracks along the mare shores (*Rimae Sosigenes* and *Hypatia* in M. Tranquilitatis), to the widespread (sic) straight stretch marks (*Rimae Aridaeus, Oppolzer, Flammarion, Reaumur*), the spectacular eroded sinuous lava channel *Rima Hyginus* and the irregular network of surface cracks constituting *Rimae Triesnecker.* Accompanying the lava fill in this fractured basin-rim area were widespread **fire fountain volcanism**, depositing layers of dark ash and glass particles, which today are seen as DMD regions at the E "shore" of Sinus Aestuum (Bode and Aestuum pyroclastics) and S of Mare Vaporum (Hyginus pyroclastics). Traces of this volcanism can also be seen today in many small cones, **domes and dark-haloed craters (DHC)** in the area, for instance W of *Manillus* and inside *Murchison.* A special type of DHC is young *Dionysius* at the W shore of Tranquilitatis; This Copernican crater shows a bright halo surrounded by an ejecta carpet with light hued rays of surface rock mixed with dark rays of underlying volcanic material. Beautiful!

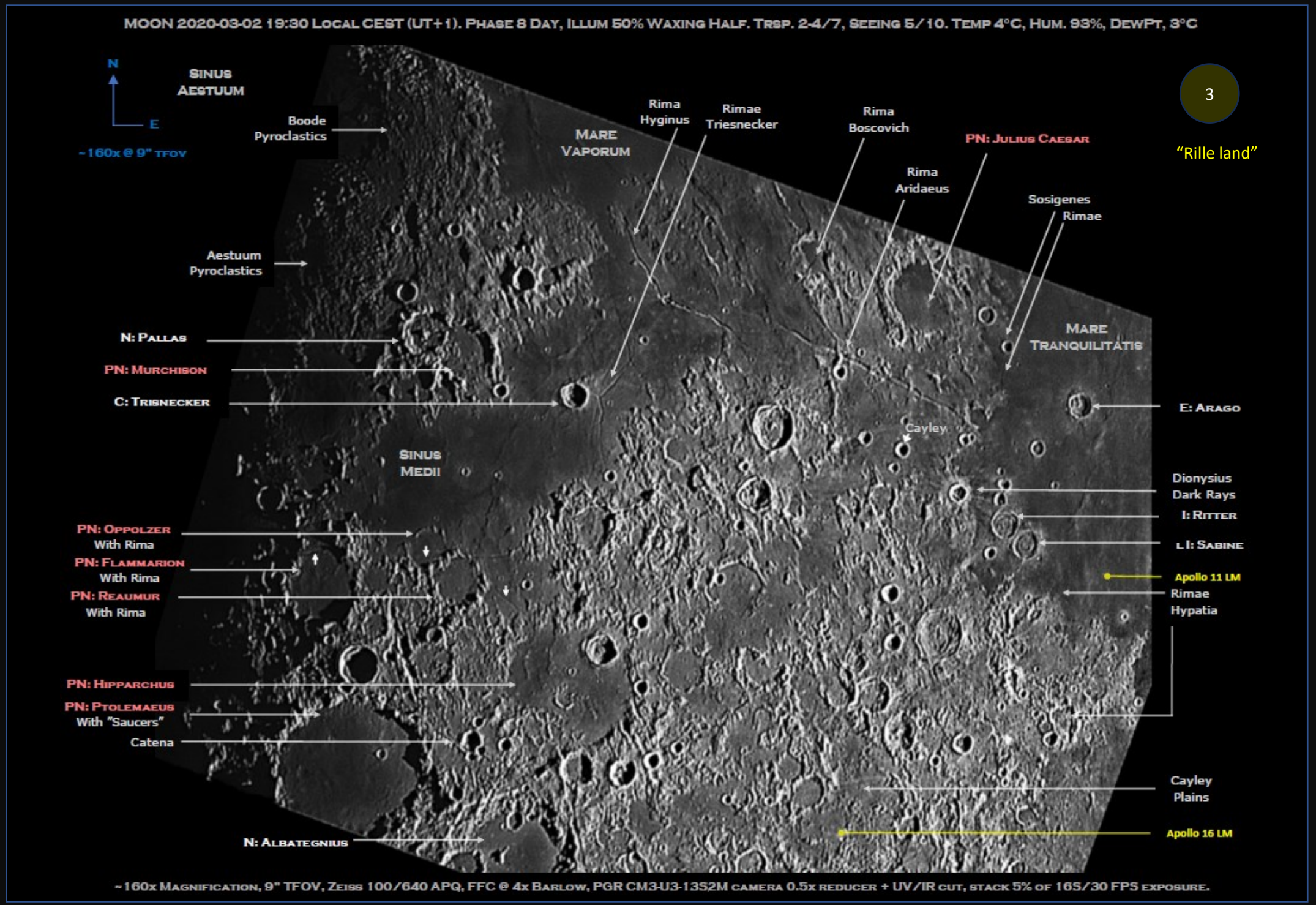
4 "Crater land"

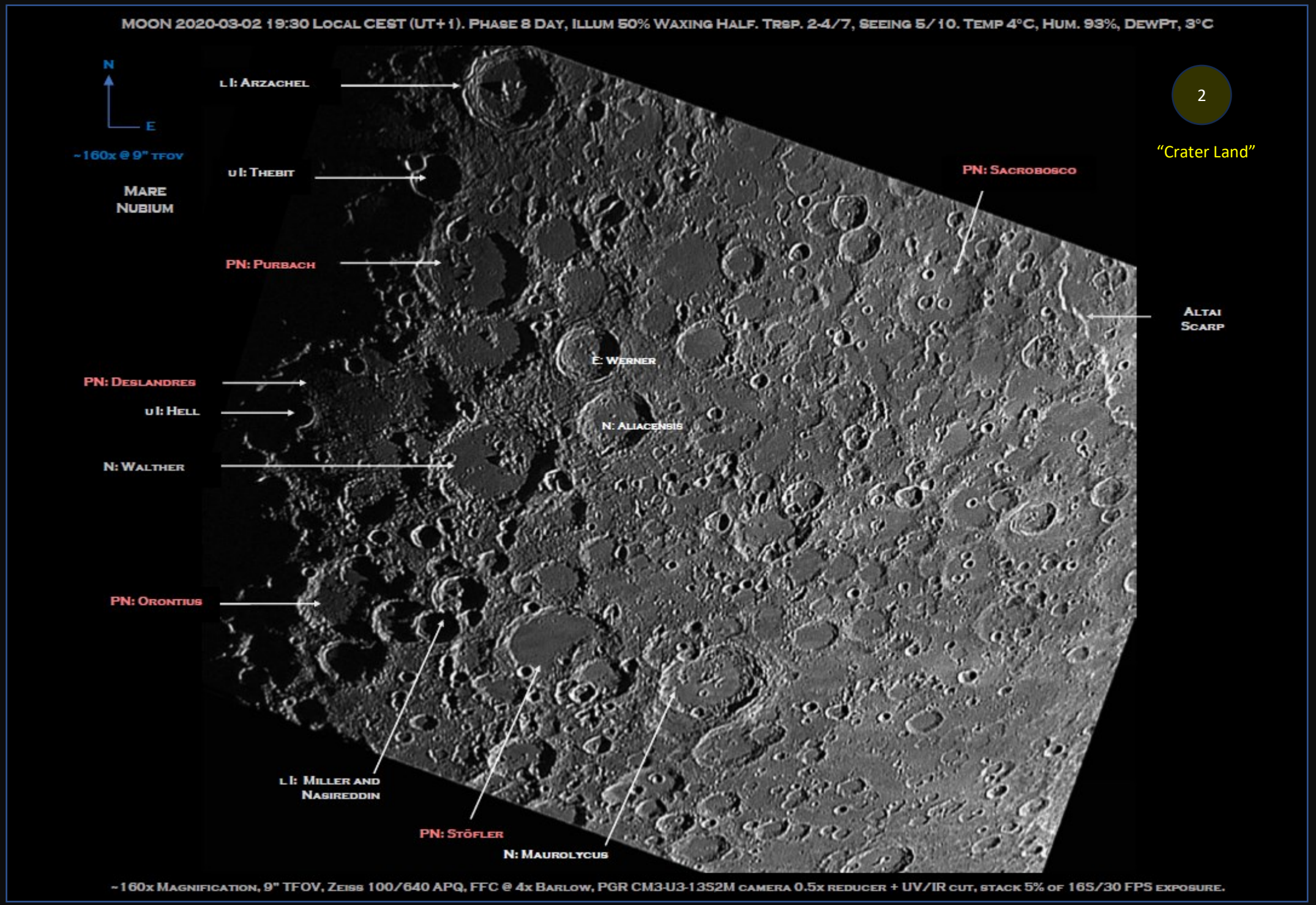
Setting foot (eyes) again on southern solid lunar terra, from the **Great Peninsula** down to the **Cratered Highlands** towards the S. Pole, -- craters upon craters upon craters. From large ancient ones (like pre-Nectarian *Sacrobosco, Purbach, Deslandres, Orontius, Stöfler, Maginus, Manzinus, Mutus, Vlacq and Rosenberger*) to old Nectarian craters (like *Walther, Aliacensis, Maurolycus, Heraclitus, Clavius, Newton*) and to young "well formed" Imbrian and Eratosthenian impacts (like *Arzachel, Thebit, Werner and Moretus*).

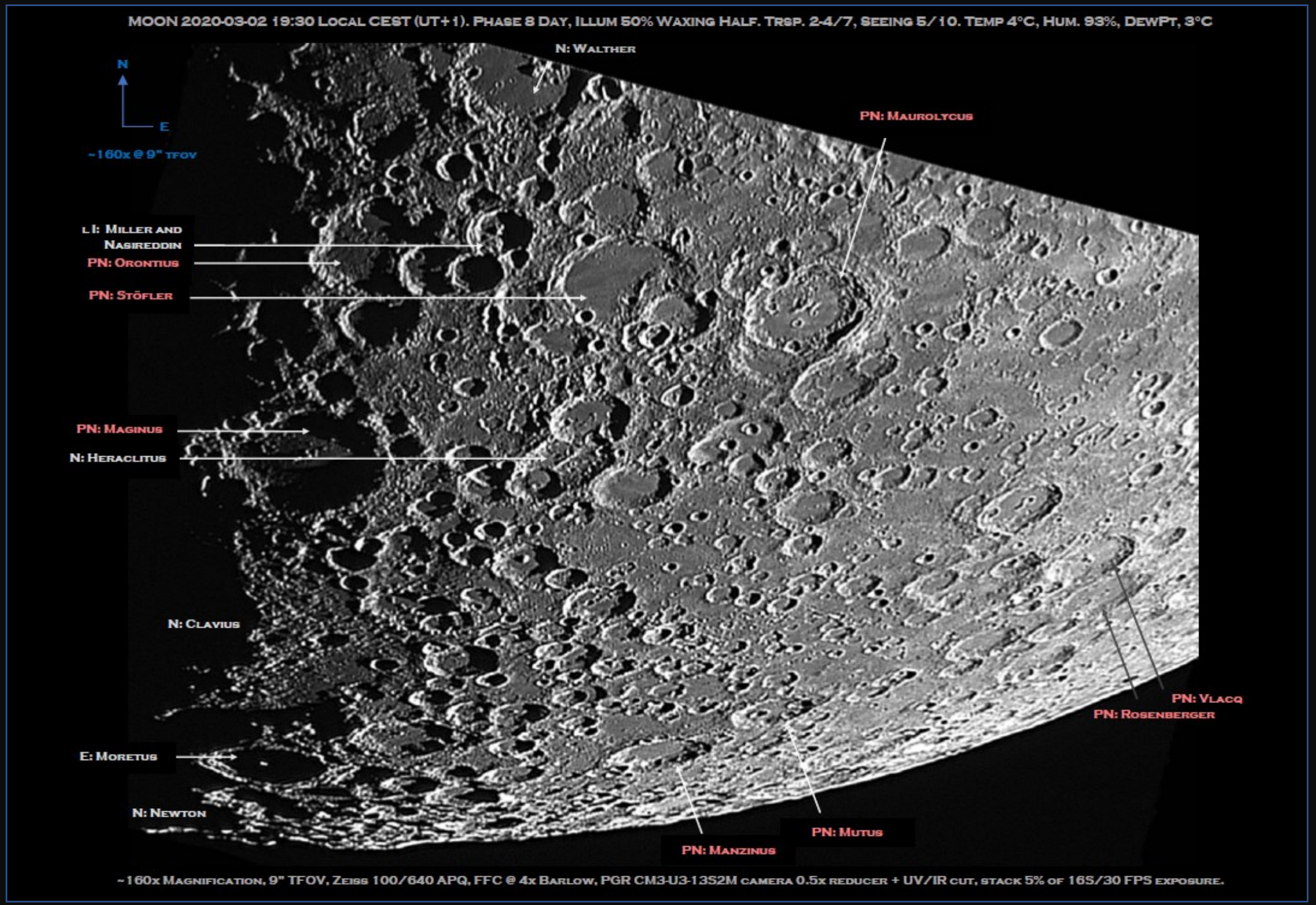
A couple of craters catch the eye: Nectarian **Walther** has a smooth floor embaying a more hummocky area towards the NE; The hilly region and secondary craters on the floor were probably formed by fast moving rocky ejecta flying in from the Imbrium Basin impact, shortly followed by a tsunami of fluidized ejecta flooding the SW part of the crater floor; Similar formations can be seen in many other of the craters. The floor of ancient **Deslandres** shows a record of lunar history, including a catena and a small lava lake towards the NE. **Stöfler** is a text book example of crater layering: it has itself overlaid two older craters towards the SW, and towards the SE no less than 4 craters have piled up one on top of the other.

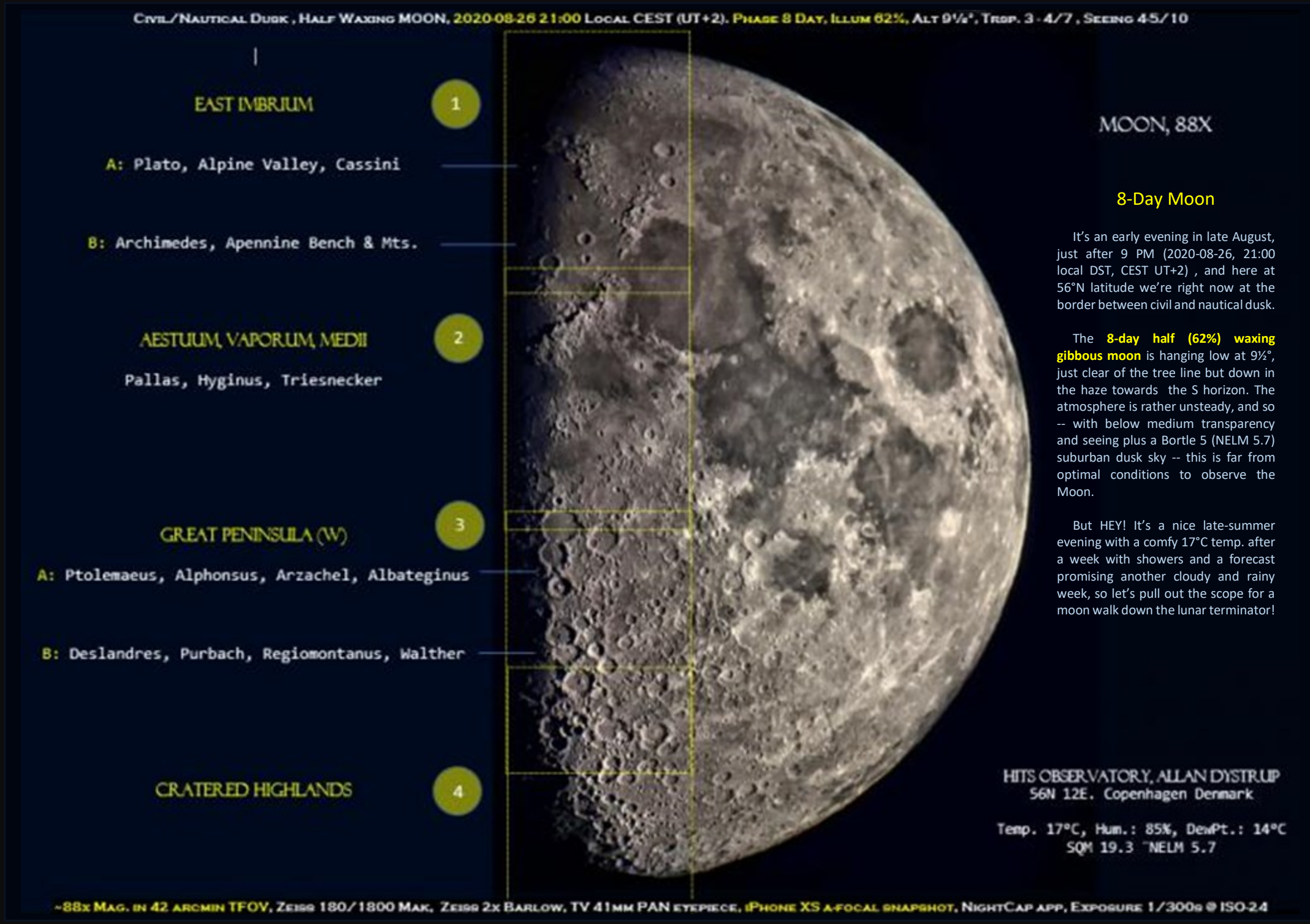
Sometimes a younger impact hammering into the crater wall of an older one will cause a landslide, as can be seen with the lower Imbrian crater pair: **Miller and Nasireddin**. At other times one (or a series of simultaneous) oblique impact(s) can form an unusual oblong crater with a central ridge such as **Heraclitus** (and also *Shiller* further W into the lunar night).

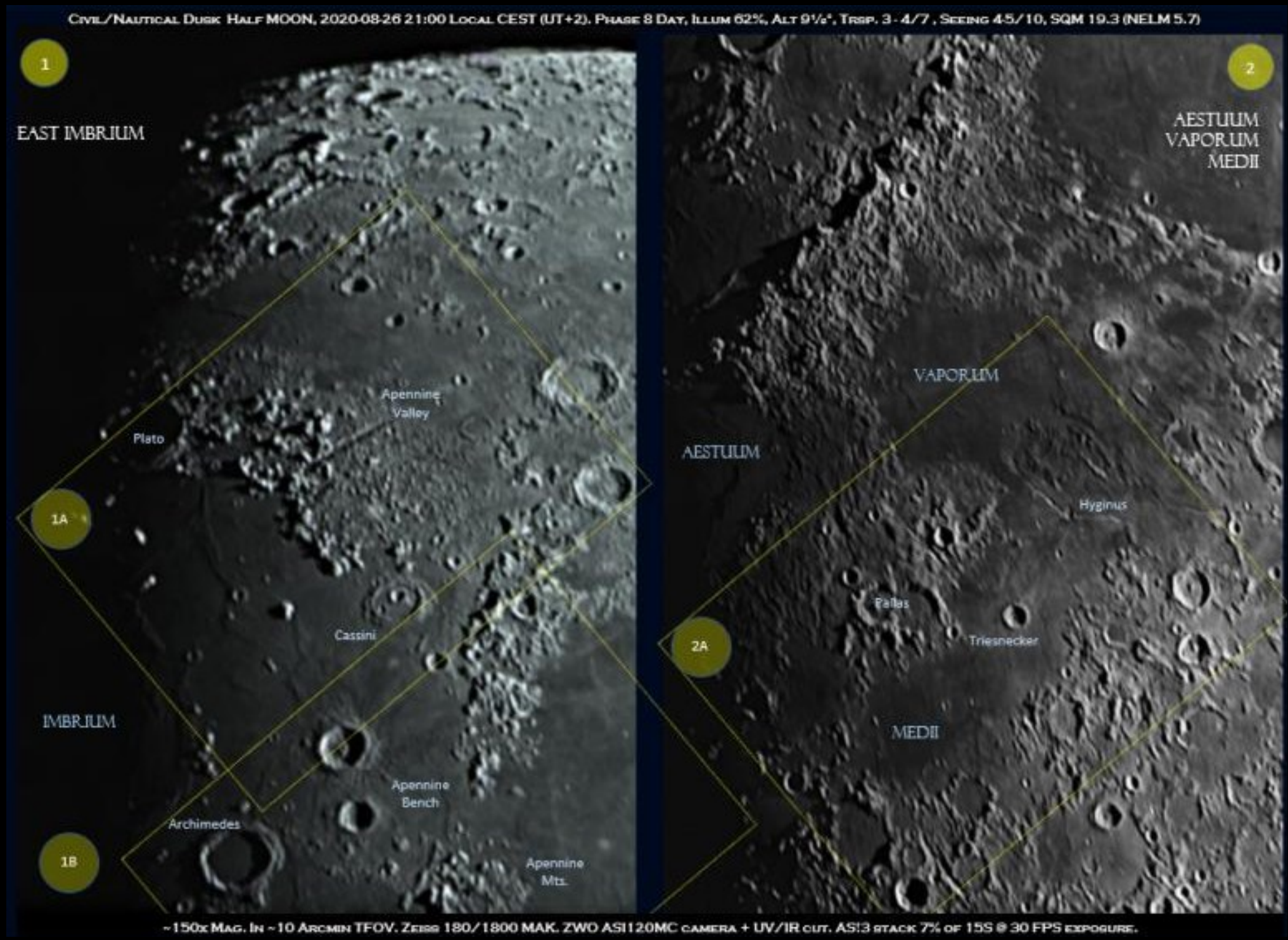
In fact, there are a lot of interesting formations here in the cratered highland, if you look closer.


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
SINUS AESTUUM
Boode Pyroclastics
Aestuum Pyroclastics
MARE VAPORUM
Rima Hyginus
Rimae Triesnecker
Rima Boscovich
Rima Aridaeus
PN: JULIUS CAESAR
Sosigenes Rimae
MARE TRANQUILITATIS
3
"Rille land"
N: PALLAS
PN: MURCHISON
C: TRISNECKER
E: ARAGO
Cayley
SINUS MEDII
Dionysius Dark Rays
I: RITTER
L I: SABINE
PN: OPPOLZER With Rima
PN: FLAMMARION With Rima
PN: REAUMUR With Rima
Apollo 11 LM
Rimae Hypatia
PN: HIPPARCHUS
PN: PTOLEMAEUS With "Saucers"
Catena
Cayley Plains
Apollo 16 LM
N: ALBATEGNIUS
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 5% OF 16S/30 FPS EXPOSURE.


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
2
"Crater Land"
L I: ARZACHEL
U I: THEBIT
MARE NUBIUM
PN: PURBACH
PN: SACROBOSCO
ALTAI SCARP
E: WERNER
PN: DESLANDRES
U I: HELL
N: ALIACENSIS
N: WALTHER
PN: ORONTIUS
L I: MILLER AND NASIREDDIN
PN: STÖFLER
N: MAUROLYCUS
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 5% OF 16S/30 FPS EXPOSURE.


MOON 2020-03-02 19:30 LOCAL CEST (UT+1). PHASE 8 DAY, ILLUM 50% WAXING HALF. TRSP. 2-4/7, SEEING 5/10. TEMP 4°C, HUM. 93%, DEWPT, 3°C
N
E
~160x @ 9" TFOV
N: WALTHER
PN: MAUROLYCUS
LI: MILLER AND NASIREDDIN
PN: ORONTIUS
PN: STÖFLER
PN: MAGINUS
N: HERACLITUS
N: CLAVIUS
E: MORETUS
N: NEWTON
PN: VLACQ
PN: ROSENBERGER
PN: MUTUS
PN: MANZINUS
~160x MAGNIFICATION, 9" TFOV, ZEISS 100/640 APQ, FFC @ 4x BARLOW, PGR CM3-U3-13S2M CAMERA 0.5x REDUCER + UV/IR CUT, STACK 5% OF 165/30 FPS EXPOSURE.


Civil/Nautical Dusk , Half Waxing MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10
EAST IMBRIUM
1
A: Plato, Alpine Valley, Cassini
B: Archimedes, Apennine Bench & Mts.
AESTUUM, VAPORUM, MEDII
2
Pallas, Hyginus, Triesnecker
GREAT PENINSULA (W)
3
A: Ptolemaeus, Alphonsus, Arzachel, Albateginus
B: Deslandres, Purbach, Regiomontanus, Walther
CRATERED HIGHLANDS
4
MOON, 88X
8-Day Moon
It's an early evening in late August, just after 9 PM (2020-08-26, 21:00 local DST, CEST UT+2) , and here at 56°N latitude we're right now at the border between civil and nautical dusk.
The 8-day half (62%) waxing gibbous moon is hanging low at 9½°, just clear of the tree line but down in the haze towards the S horizon. The atmosphere is rather unsteady, and so -- with below medium transparency and seeing plus a Bortle 5 (NELM 5.7) suburban dusk sky -- this is far from optimal conditions to observe the Moon.
But HEY! It's a nice late-summer evening with a comfy 17°C temp. after a week with showers and a forecast promising another cloudy and rainy week, so let's pull out the scope for a moon walk down the lunar terminator!
HITS OBSERVATORY, ALLAN DYSTRUP
56N 12E. Copenhagen Denmark
Temp. 17°C, Hum.: 85%, DewPt.: 14°C
SQM 19.3 NELM 5.7
~88x Mag. in 42 arcmin TFOV, Zeiss 180/1800 Mak. Zeiss 2x Barlow, TV 41mm PAN eyepiece, iPhone XS a-focal snapshot, NightCap app, Exposure 1/300s @ ISO-24


Civil/Nautical Dusk Half MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10, SQM 19.3 (NELM 5.7)
1
EAST IMBRIUM
Apennine Valley
Plato
1A
Cassini
IMBRIUM
Apennine Bench
Archimedes
1B
Apennine Mts.
2
AESTUUM VAPORUM MEDII
VAPORUM
AESTUUM
Hyginus
Pallas
Triesnecker
2A
MEDII
~150x Mag. In ~10 Arcmin TFOV. Zeiss 180/1800 MAK. ZWO ASI120MC camera + UV/IR cut. AS!3 stack 7% of 15S @ 30 FPS exposure.

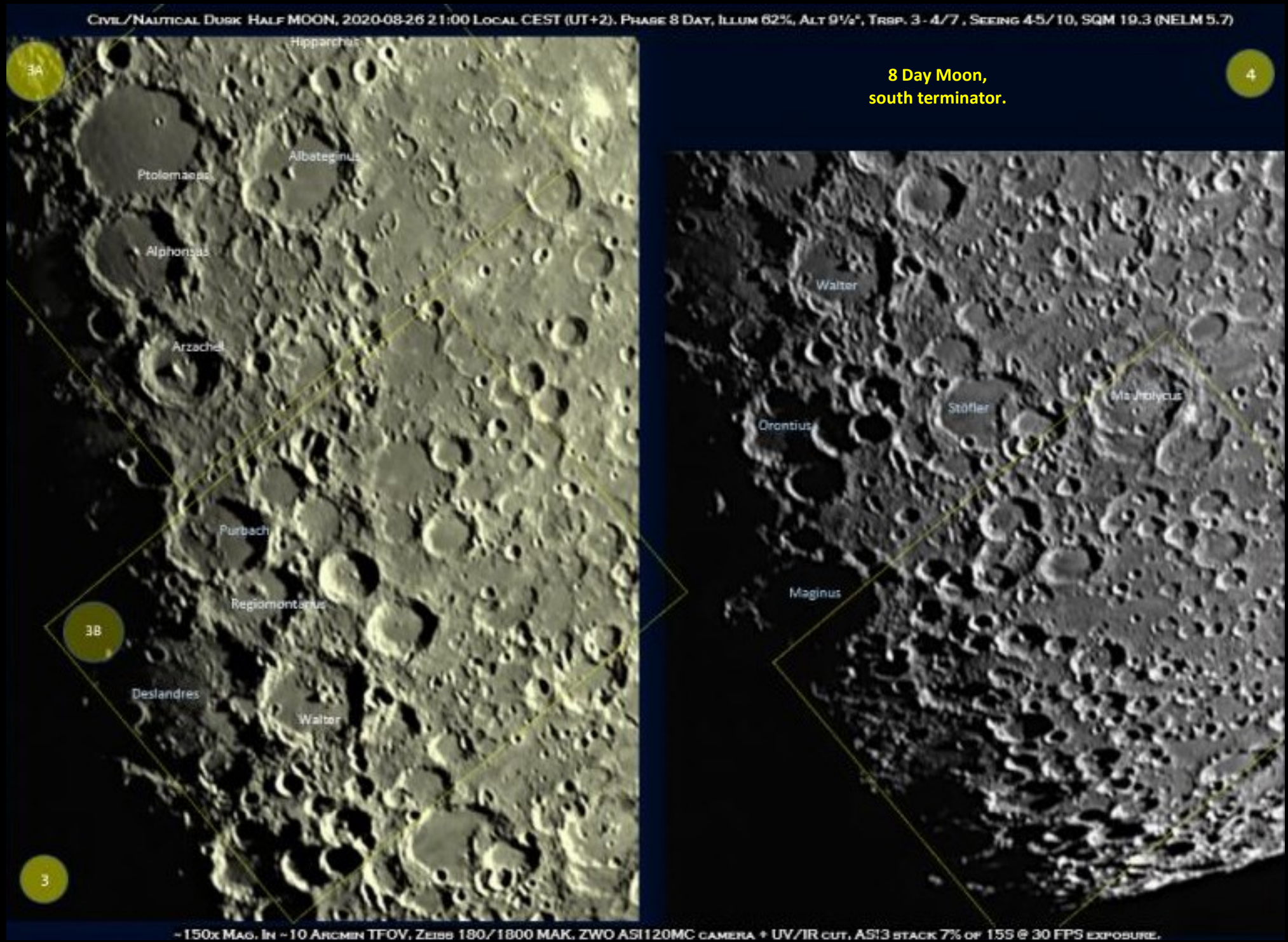

Civil/Nautical Dusk Half MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10, SQM 19.3 (NELM 5.7)
1A
N
E
Plato
EAST
IMBRIUM
Pico
Apennine
Valley
Piazzi
Smyth
Kirch
Piton
Spitzbergen
Mts.
Cassini
Aristillus
~300x Mag. In ~ 5 Arcmin TFOV. Zeiss 180/1800 MAK. Zeiss 2x Barlow. . ZWO ASI120MC camera + UV/IR cut. AS!3 stack 7% of 15S @ 30 FPS exposure.

8-Day Moon, [1] East Imbrium.

In **East Imbrium**, several wrinkle ridges are seen in the lava flows: one ridge from Mons Spitsbergen stretching up W of Kirch and continuing N to Mons Pico, and another lava surf breaking against the crater wall of Piazzi Smyth, then wiggling up N to the crater wall of Plato.

The light hued **Apennine Bench** SE of Archimedes is made, partly of igneous rock erupted on the basin floor, and partly of landslide blocks from the Apennine basin wall, when the excavated floor was uplifted soon after the Imbrium impact (leaving steep-sloped mountain faces like Huygens, Bradley and Hadley). In the following upper-Imbrian lava flooding, only part of the Apennine Bench was submerged, including the floor of Archimedes and the low area now known as Palus Putredinis. The young craters Aristillus and Autolycus showing distinct ejecta carpets were created later, by Copernican impacts in the Mare Imbrium lava plains.


CIVIL/NAUTICAL DUSK HALF MOON, 2020-08-26 21:00 LOCAL CEST (UT+2). PHASE 8 DAY, ILLUM 62%, ALT 9½°, TRSP. 3 - 4/7 , SEEING 4-5/10, SQM 19.3 (NELM 5.7)
2A
8-Day Moon [2]
Aestuum,
Vaporum, Medii
The landscape N of the Central Bay (Sinus Medii) is dominated by a couple of dark mantle deposits (DMD) from lava eruptions; -- most obvious in this image are the DMD on the 3 parallel rubbly hilly ridges of Imbrium ejecta N of the Hyginus crater, -- and you can spot some of the fire fountain vents in the collapsed lava channel known as the Hyginus Rille.
Also glimpsed on the image are the narrow intertwined Triesnecker Rilles, probably mare lava cracks pulled apart by uplifting caused by rising mantle material.
AESTUUM PYROCLASTICS
MARE VAPORUM
N
E
HYGINUS PYROCLASTICS
Pallas
Murchison
Hyginus
SINUS MEDII
Triesnecker
Rima Aridaeus
Agrippa
~300x MAG. IN ~ 5 ARCMIN TFOV. ZEISS 180/1800 MAK. ZEISS 2x BARLOW. . ZWO ASI120MC CAMERA + UV/IR CUT. AS!3 STACK 7% OF 15S @ 30 FPS EXPOSURE.


Civil/Nautical Dusk Half MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10, SQM 19.3 (NELM 5.7)
3A
Hipparchus
Albategnius
Ptolemaeus
Alphonsus
Arzachel
Purbach
Regiomontanus
3B
Deslandres
Walter
3
8 Day Moon,
south terminator.
4
Walter
Stöfler
Orontius
Maginus
~150x Mag. In ~10 Arcmin TFOV, Zeiss 180/1800 MAK, ZWO ASI120MC camera + UV/IR cut, AS!3 stack 7% of 155 @ 30 FPS exposure.

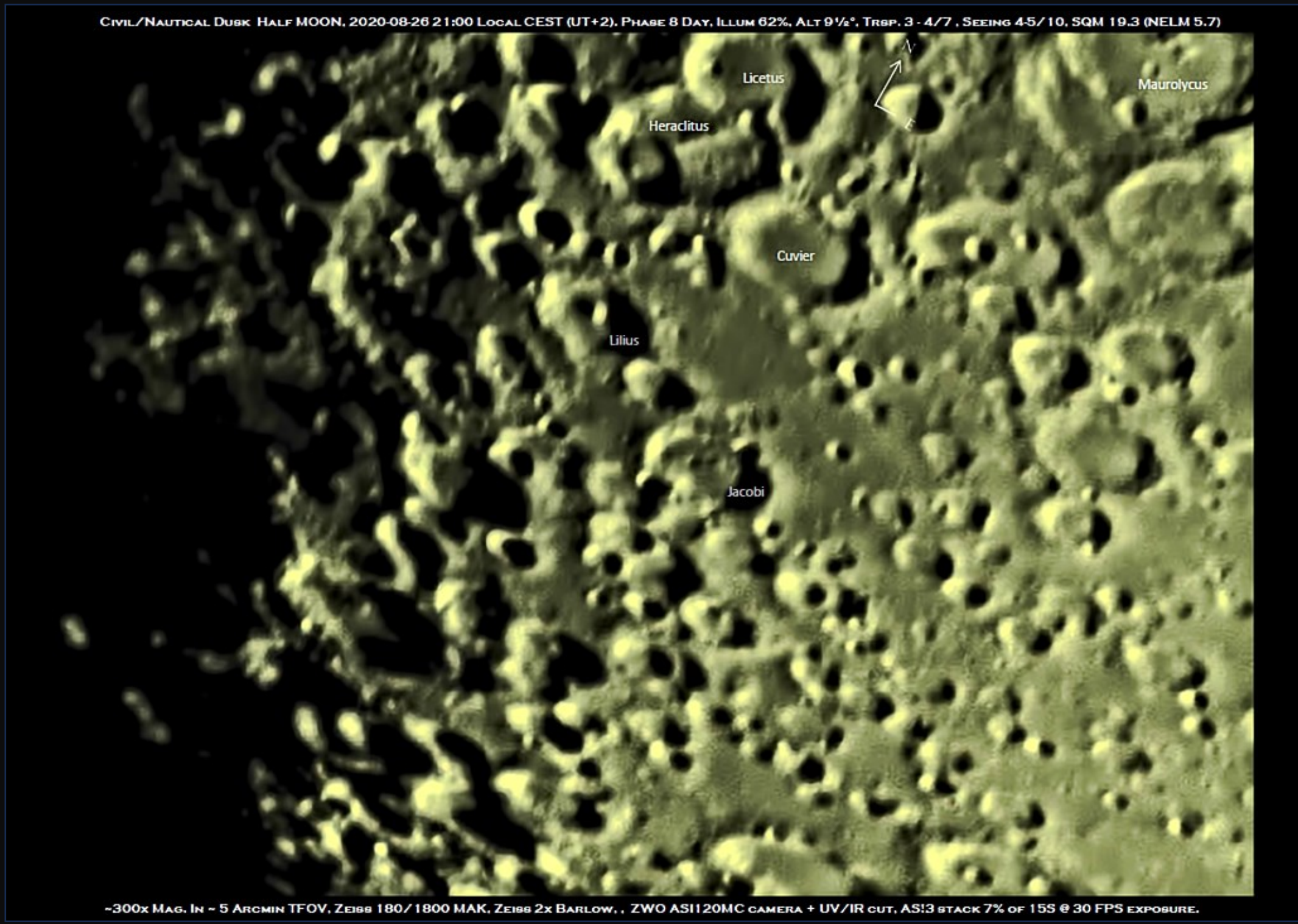

Civil/Nautical Dusk Half MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10, SQM 19.3 (NELM 5.7)
3A
8-Day Moon:
[3] Great Peninsula (W)
Several long furrows/troughs are slicing through the highlands in the W part of the Great Peninsula, all radial to the Imbrium Basin and thus of course all Imbrium Sculpture features.
In the low sun along the terminator, the smooth floor of the 153 Km wide pre-Nectarian Ptolemaeus walled plain shows several small 5-10 Km craters that have been almost fully covered by a combination of intruding mantle magma plus Imbrium Basin impact melt and pulverized ejecta; These craterlets are now only detectable as shallow hollows ("saucers") in the walled plain of Ptolemaeus. I've marked five of the more obvious saucers, including the largest one, named Ptolemaeus B.
The nearby but younger (Nectarian) walled plain craters Alphonsus and Albategnius also show overall smooth floors, Alphonsus with both signs of volcanic activity (rilles, dark-haloed craters) but also a striking diagonal ridge of Imbrium ejecta, and Albategnius with a couple of saucers, just like Ptolemaeus.
Ptolemaeus
B
A
N
E
Hipparchus
Alphonsus
Albategnius
Arzachel
~300x Mag. In ~ 5 Arcmin TFOV, Zeiss 180/1800 MAK, Zeiss 2x Barlow, , ZWO ASI120MC camera + UV/IR cut, AS!3 stack 7% of 15S @ 30 FPS exposure.

8-Day Moon:
[3] Great Peninsula (W) continued: Deslandres, Purbach, Regiomontanus, Walther

Deslandres is an ancient (pre-Nectarian) 256 Km wide, walled plain (or small lunar Basin); It is heavily degraded, and was in early lunar cartography only marked as "Hell Plain" after the family of "Hell" craters on the Deslandres impact floor. There's a line of 5 craterlets: a Catena, at the NE quadrant of the Hell Plain, pointing south towards a small group of young craterlets including Hell-Q with a light hued halo of ejecta known as Cassini's Bright Spot (best seen at full moon). Well seen on the image is also a valley (a Graben) that extends from the center of Deslandres down SE, cutting through the N crater wall of **Lexell**.

Purbach and Regiomontanus are a couple of other old (pre-Nectarian) and battered craters, bordered on the south by the younger (Nectarian) and more well-preserved crater **Walther**. Purbach and Regio both have a relatively smooth floor filled in by ejecta from later impacts, which have left only breached saucer-like crater rims (like Purbach W). The central peak of Regio has a craterlet (A) at the summit, which before the Apollo era by some (like Patrick Moore) were interpreted as a volcanic vent, but spectral analysis has since determined that the central peak is made of not basalt but just normal highland rock. At the impact of Walther, the E crater wall pushed into the smaller **Nonius** crater, leaving an unusual triangular depression.

Many other details can be seen in this area, -- to mention a few: the floor of **Blanchinus** streaked with ejecta from **Werner**, the landslide from **Nasireddin** into **Miller**, the Werner White Spot on the N crater wall around crater D (best seen at high sun), part or the **Werner-Airy fossil basi**n, and "The" so called Lunar X (which is just one random alignment of 4 craters, of which there are countless forming any figures you can imagine, from the alphabet to eyes, faces etc. and so on...).


Civil/Nautical Dusk Half MOON, 2020-08-26 21:00 Local CEST (UT+2). Phase 8 Day, Illum 62%, Alt 9½°, Trsp. 3 - 4/7 , Seeing 4-5/10, SQM 19.3 (NELM 5.7)
N
E
Licetus
Maurolycus
Heraclitus
Cuvier
Lilius
Jacobi
~300x Mag. In ~ 5 Arcmin TFOV, Zeiss 180/1800 MAK, Zeiss 2x Barlow, , ZWO ASI120MC camera + UV/IR cut, AS!3 stack 7% of 15S @ 30 FPS exposure.

8-Day Moon
Overview

It's the end of March and I'm out in the evening to study the 8-Day Moon (2021-03-21 @ 22:00 Local CEST, UT+1). The waxing half Moon is well up at 41° altitude above the W horizon, the weather is cool and calm, and both transparency and seeing are well above medium. All-in-all a splendid evening, so I plug in a 500nm Green Bandpass filter on my Zeiss 100/640mm refractor, and off we go for a sweep down the lunar terminator.

I first take in **the full-frame view of the half-moon,** -- crisp and clear and ready to go for higher resolution tonight! Many interesting areas to study (Alpine Valley and Cassini, Apennine Bench and Mountains, the Hyginus-Triesnecker rille area, the Ptolemaeus-Alphonsus-Arzachel craters...), but I decide to concentrate on the **Southern Highlands**, from Deslandres down to the South Pole.

Ahh well, -- sweeping across one of my favorite lunar landscapes (the **ABF**), I decide to spend some time enjoying this geologically interesting formation too, so I may as well share this observation here also...

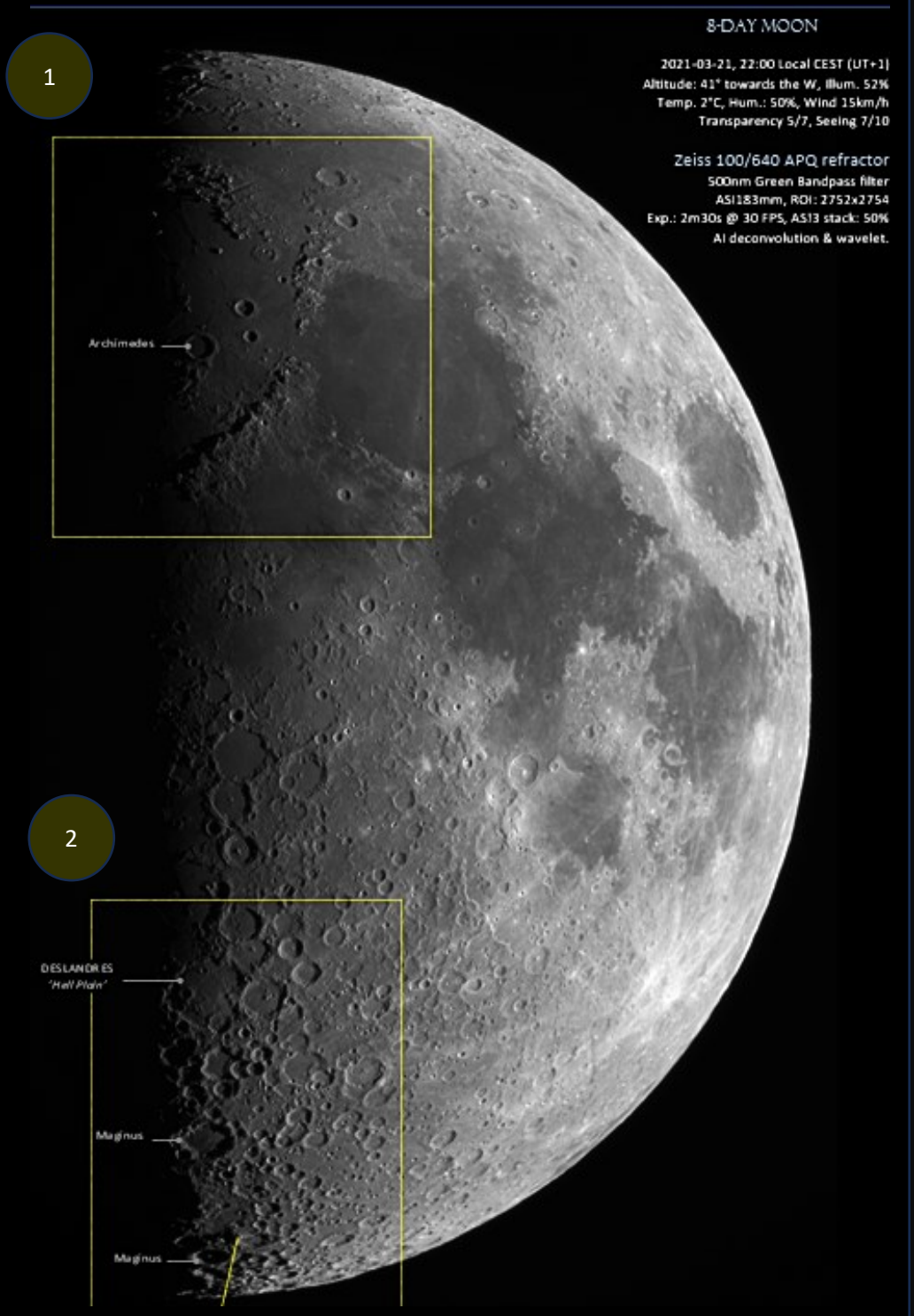
1 Crop: Apennine Bench

ABF (the *Apennine Bench Formation*) consists of several light-hued, hummocky plains found mostly between the second ring (Archimedes/Wrinkle Ridge) and the third ring (Apennine/Basin Rim) of the Imbrium basin; -- The ABF includes terra-formations that are topographically higher than the mares but lower than the highlands.

The ABF was formed on the Imbrium basin floor shortly after the Imbrium impact (period Lover Imbrium: 3.84 Byr) by KREEP-rich magma erupting from the upper lunar mantle through deep cracks in the thin crust, which was already shattered by the Procellarum basin impact. The large, early Imbrian crater **Archimedes** impacted directly on top of the ABF-plains, (around ~3.7 Byr ago) next to a part of the Imbrium basin rim (the Apennine Mts.) that has slid down as slump terrasses (now known as the Archimedes Mts.)

Later (in Upper Imbrium: 3.6-3.2 Byr) massive, low viscosity basaltic lava floodings filled the Imbrium basin to about half its original depth, thus creating **Mare Imbrium** (and also flooding the other major impact basins on 30% of the lunar near-side). The Imbrian lava flooding embayed the Archimedes Mts. and crater, seeped up through cracks in the Archimedes crater floor and covered part of the ABF east of Archimedes (now known as Palus Putredinis).

Later still, other large impacts occurred on the ABF, each throwing out ejecta carpets covering the surroundings; Most notable examples are **Autolycus** (Eratosthenian: 2.1 Byr) and the more recent **Aristillus** (Copernican: 1.3 Byr), still with obvious radiating ridges.



1

8-DAY MOON CROP: ABF

2021-03-21, 22:00 Local CEST (UT+1)
Altitude: 41° towards the W, Illum. 52%
Temp. 2°C, Hum.: 50%, Wind 15km/h
Transparency 5/7, Seeing 7/10

Zeiss 100/640 APQ refractor

500nm Green Bandpass filter
ASI183mm, ROI: 2752x2754
Exp.: 2m30s @ 30 FPS, AS!3 stack: 50%
AI strong deconvolution & wavelet.

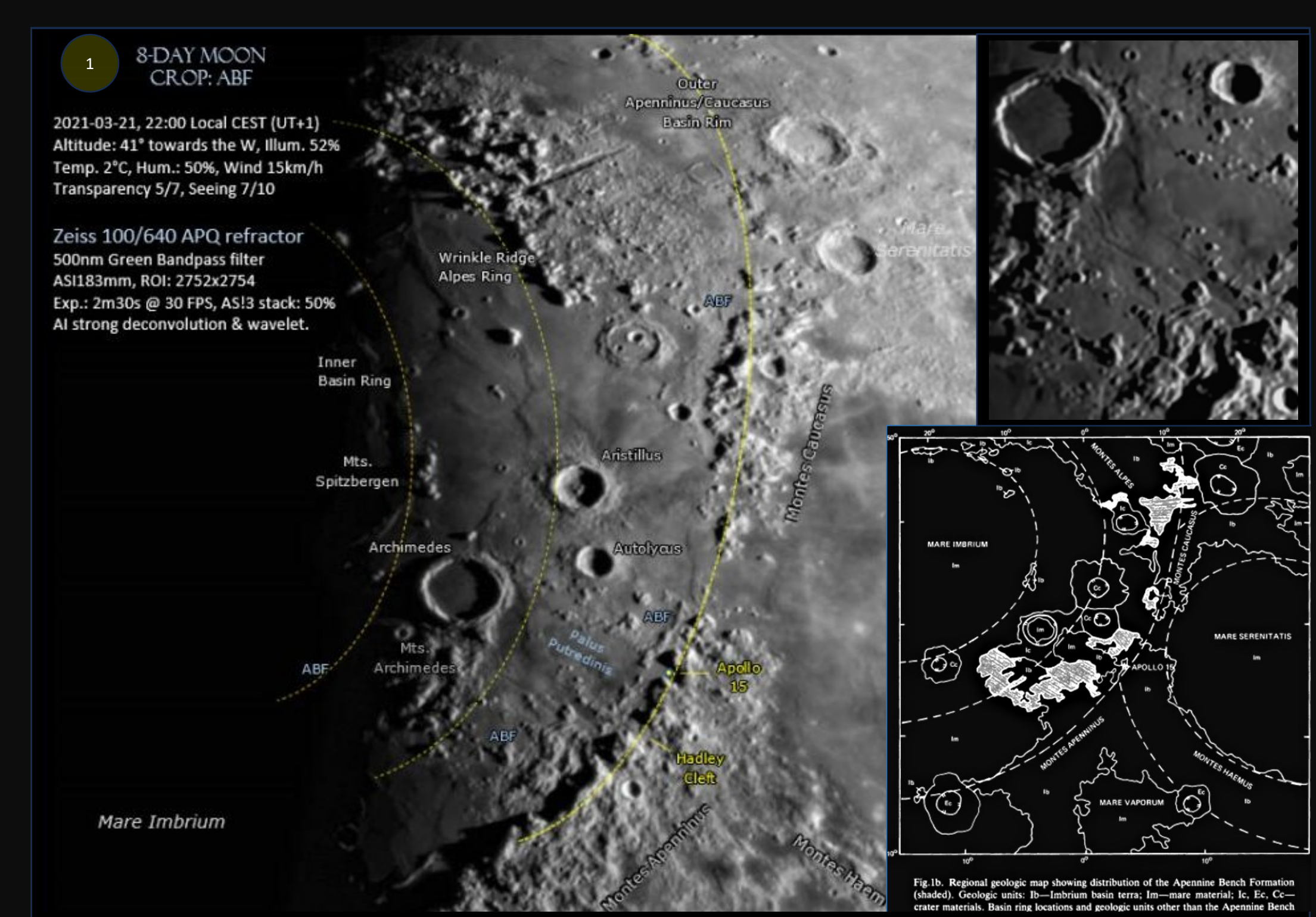


Fig.1b. Regional geologic map showing distribution of the Apennine Bench Formation (shaded). Geologic units: Ib—Imbrium basin terra; Im—mare material; Ic, Ec, Cc—crater materials. Basin ring locations and geologic units other than the Apennine Bench

2

Crop: Deslandres

The **Southern Cratered Highlands** have seen no major Imbrium mare-lava floodings, but are dominated by ancient impacts in the lunar terra crust. Some of the largest impacts in this area are **the old pre-Nectarian basin structures**: *Werner-Airy (VA: 500km ø) and Mutus-Vlacq (MV: 700km ø),* but the large walled "Hell Plain" Deslandres (235km ø) can also be considered a smaller basin impact with a possible 70km ø inner ring.

The **Nubium Basin** bordering on the Highlands towards NW is also Pre-Nectarian (but older than Deslandres), and it was mare-filled in the great Upper Imbrian lava flows; The Highlands though, including the ancient basins VA and MV, were not flooded by the Imbrian basaltic lavas, but instead repeatedly molded and battered by impact cratering; This long-lasting bombardment has resulted in a zone of ancient fractured megaregolith (brecciation) down to on average 2km depth, overlaid by a ~10m layer of smoother regolith plains material from the cratering ejecta consisting of impact melt and pulverized crust.

As an example, the floor of **Deslandres** is rough, pockmarked by several medium-size primary craters: Lexell, Walter W, Hell ("ghost", A, B, C) and on top of that, pitted by countless smaller secondary craters, some in chains (catenae) and clusters, like the one that includes Cassini's "bright spot". Also note the 110km long (unnamed) trough (valley) running diagonally from NW towards NE, -- radially to Imbrium, which may indicate the origin of this formation.

A couple of patches towards the NE on the Deslandres crater floor are smoother and darker than the rest, maybe caused by non-mare volcanism. Some surrounding craters - including **Regiomontanus, Walter and Stöfler** - have larger areas with smooth (young) floors, possibly formed by dark non-mare volcanism and later streaked with light hued impact ejecta (?).

A note on the use of filters for lunar observation:

I seldom use any filters for **visual** observation of the solar system with my APOs; With achromats I have obtained increased contrast using a light-blue or green (540nm) on the sun and a yellow (495nm) on the moon; Even a semi-APO like my Zeiss AS 80/840 benefited from the yellow filter. These color bandpass filters work by reducing the effect of chromatic aberration. For **photography** there are several factors in play:

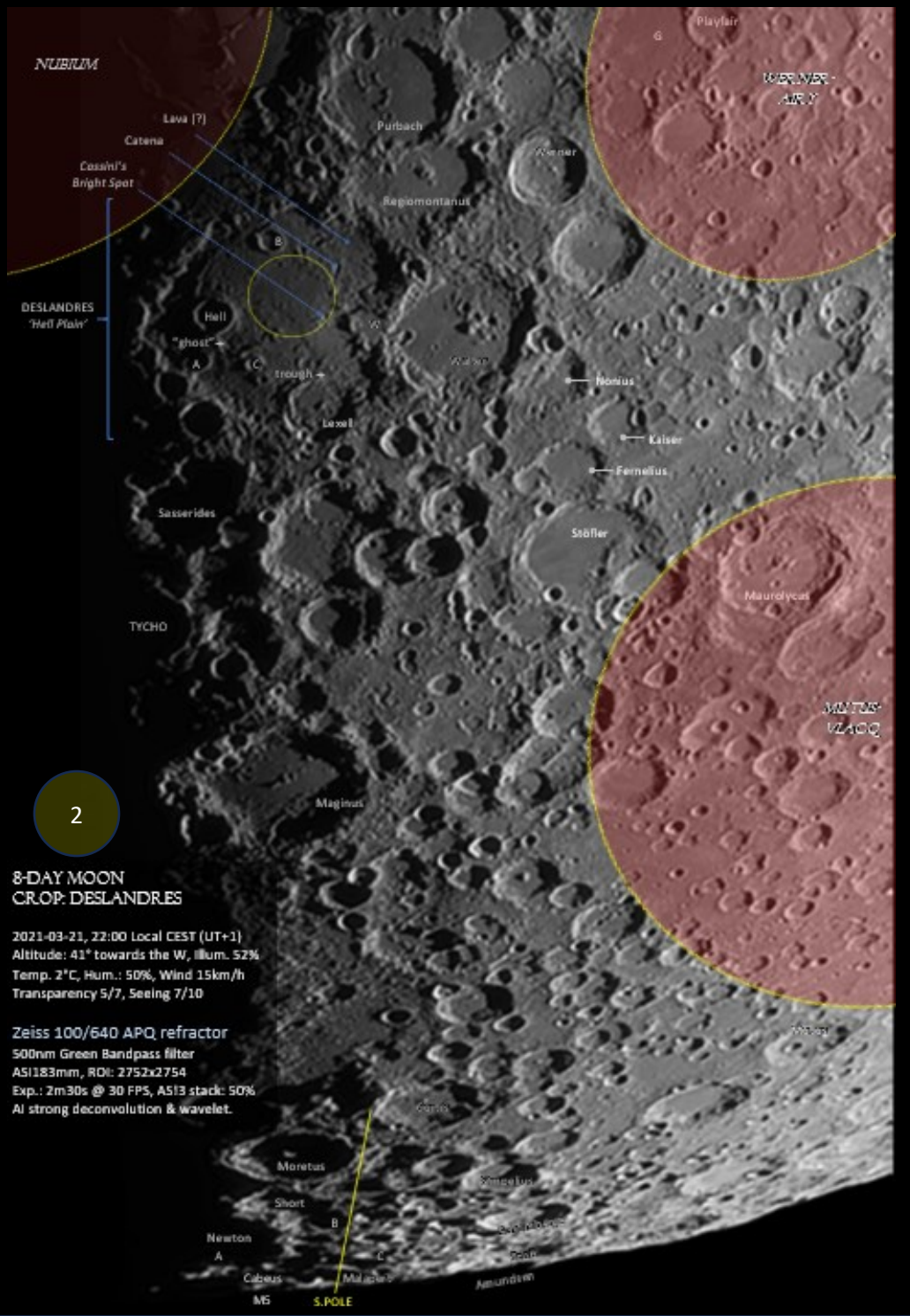
- angular resolution (AR): imaging in shorter wavelengths (green bandpass with UV/IR block) increases the AR; Blue light is scattered more by the atmosphere, which decreases the AR here on the surface of the Earth (maybe better on Mars?)

- atmospheric turbulence (AT): imaging in longer wavelengths (red into IR) is less affected by adverse seeing and transparency; The larger the aperture (above say 4") the more negative effect of AT.

I currently image with a **monochrome sensor** (IMX183mm) at prime focus on my preferred small(ish) 4" f/6.4 APO; I observe from my suburban backyard in a temperate costal climate N of Copenhagen (Denmark), where my seeing and transparency are mostly around medium, often below that and seldom good to excellent. I don't bother imaging in well below medium seeing (high AT and/or low transparency).

I use a red (610nm longpass) filter for dusk/dawn or daytime lunar imaging, -- not so much to reduce the effect of AT (my preferred aperture being only 4"), but primarily to increase contrast. My 180 f/10 Mak was more sensitive to AT and thus less time diffraction limited, so I did more often use a red filter on that scope.

I use a green (610nm bandpass) on my 4" refractor in medium to excellent seeing with good results for increased AR.



1.Quarter Moon – 8 Days

56N 12E, Copenhagen DENMARK.
2024 Feb. 18., 18-19h Local CEST (UT+1)
Clear, a bit of high haze (lunar halo) and 3% high clouds
Trsp.: 4/7, Seeing: 4-5/10, LP: Bortle 5 Suburban
Temp 1°C, Hum. 85%, DewPt. 0°C

It's a late, cool (1°C) afternoon in mid-February (2024-02-18) and I'm out in my suburban backyard with my 4" refractor to study the Moon.

Here at 56N 12E and 18:00 Local, it's now the start of Nautical dusk moving into astronomical dusk in 45 minutes, so the Moon is only accompanied by Jupiter ~30° to the SW (no stars yet). The transparency and seeing are both only ~ medium this evening, but the Moon is sailing high up (+26°) close to the meridian, so the view is OK, albeit with a faint halo from thin high haze.

The libration (-5° Lat., +6½°Long.) is favoring the SE horizon, so I'll be sure to take a closer look at the SE Limb with *Mare Australe*, but apart from that, both the Apennine Bench and the large crater chains at the W side of the Great Peninsula are well placed along the terminator, and the Nectaris-Colchis region I s also inviting a closer look, right at the center of the illuminated part of the Moon.

I start with an overview, using a Zeiss 2x barlow + an Ethos 21mm EP... Wow, a lot of details, though seen through some turbulence in the upper atmosphere. I catch a 90s video of the 1Q Moon view, using my IMX-183MM chip, though the read-out logic of the ASI camera is periodically and increasingly failing, and I'm afraid that it is now definitely on its death bed. Not a great fan of how ZWO is packaging and software bundling the chips for photography!

I give up on the *ZWO Cam.*, and instead I dig out my old *PGR Chameleon 2*, which is always a joy to use, though it has a smaller ICX445 chip.

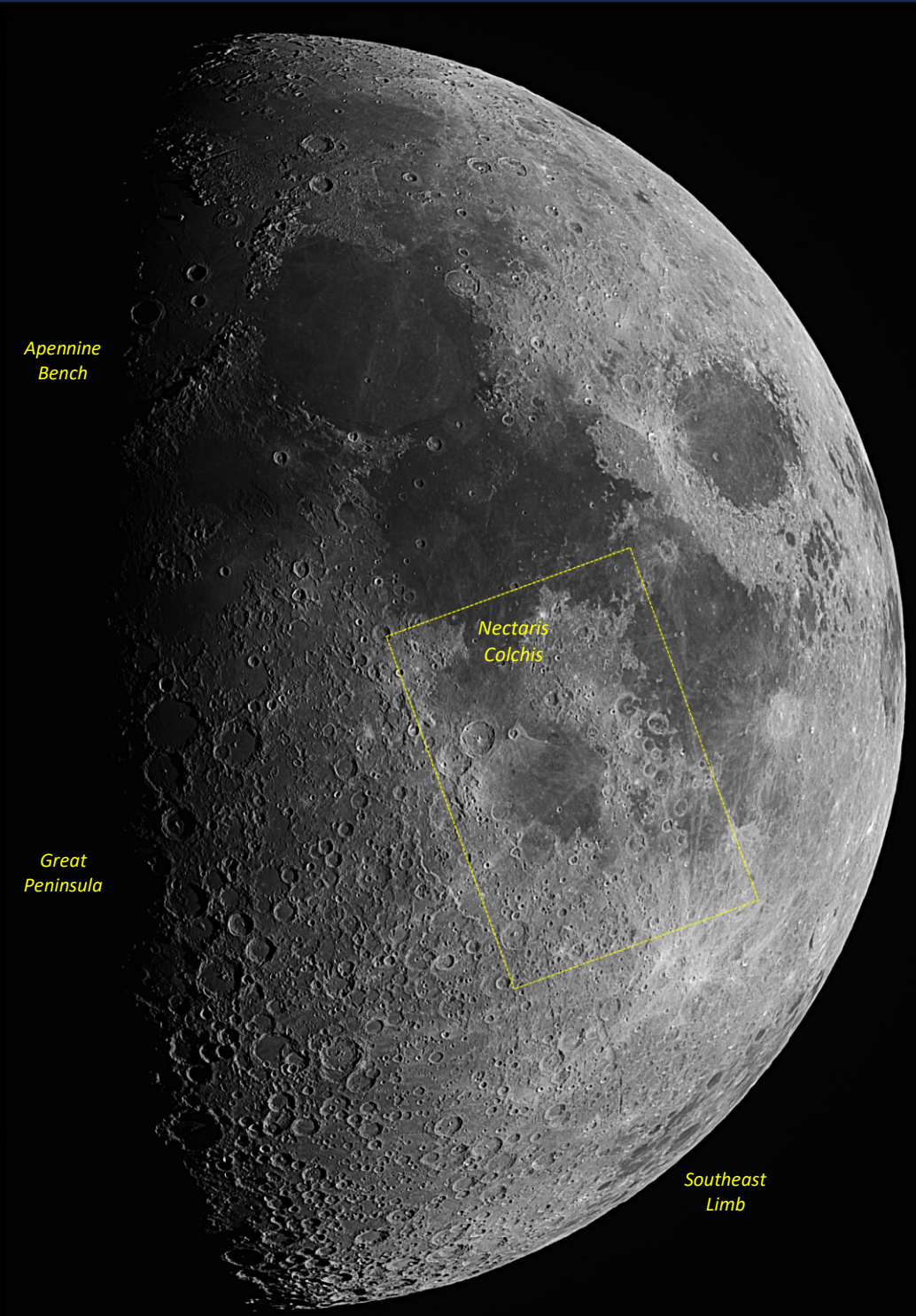
The Apennine Bench shows a rough terrain of igneous hills and rocks erupted ~3.8 Myr ago on the newly excavated floor of the *Imbrium Basin*, and afterwards flooded by lava flows that embayed the *Archimedes* crater and formed the *Palus Putredinis* plain SE of Archimedes. Also noteworthy is the splendid ejecta carpet of the young (Copernican, ~1 Byr) crater on top of the lava plain.

The Great Peninsula is the name of the central, cratered highlands surrounded by basin impacts (later lava filled mares) with Nubium to the W, Insularum-Medii to the N and Tranquilitatis–Asperitatis–Nectaris to the E . The western side of the 'Peninsula' is dominated by large crater trios, including: Ptolemaeus–Alphonsus–Arzachel, Purbach–Regiomontanus–Walther, Blanchinus–Werner–Aliacensis, and others!

The Nectaris-Colchis region shows many interesting details, including the Eratosthenian (~2 Byr) *Mädler* ejecta carpet, the bright Copernican (~1 Byr) impact bowl of *Censorinus*, the crater chain through Capella, and much more!

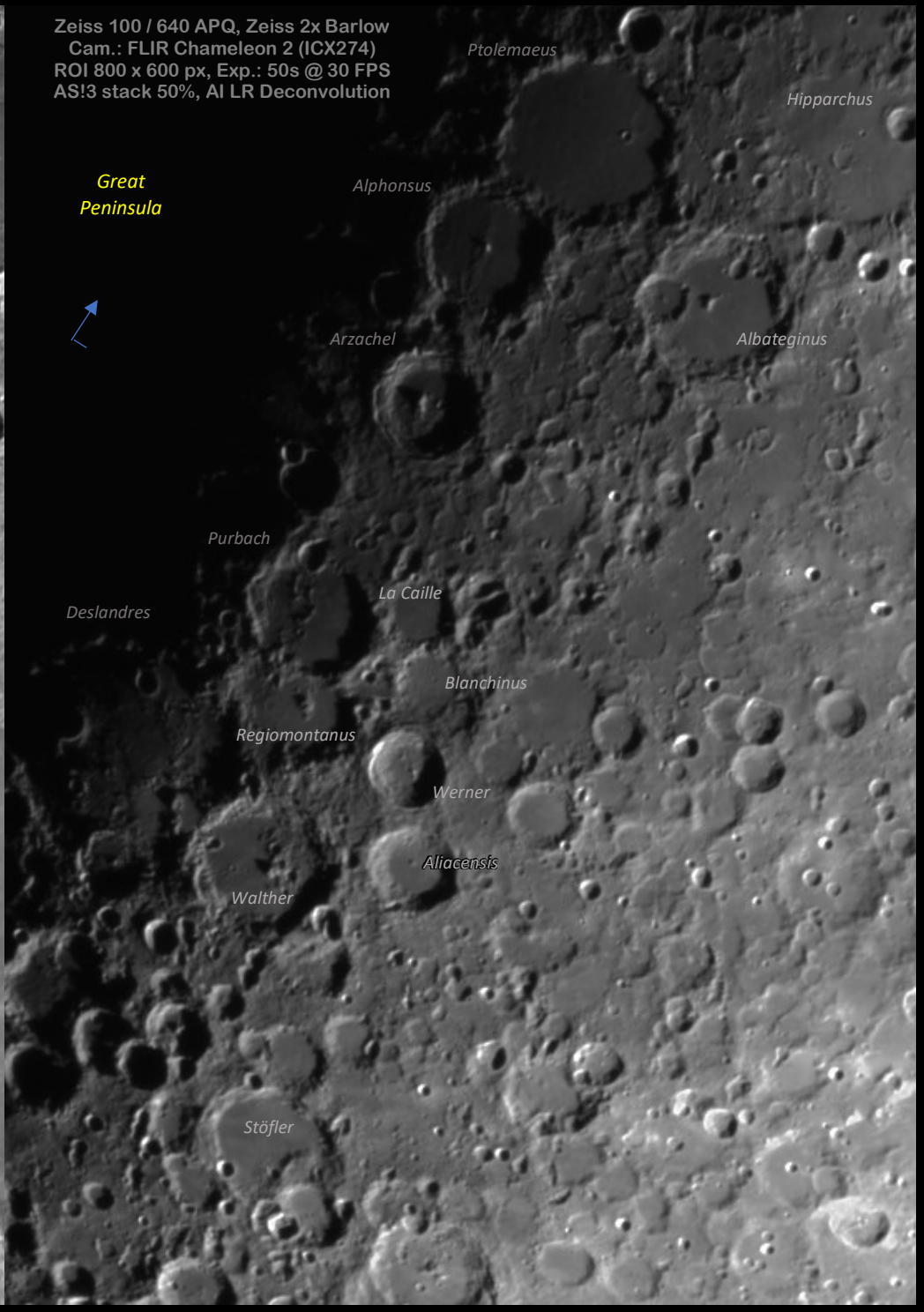
Finally, the Southeast Limb with the *Rheita Vally* and *Mare Australe* showed up well, due to the favorable libration; The *Altai Scarp* and the radial ejecta ridges from the Nectaris Basin excavation were also well seen in this observation.

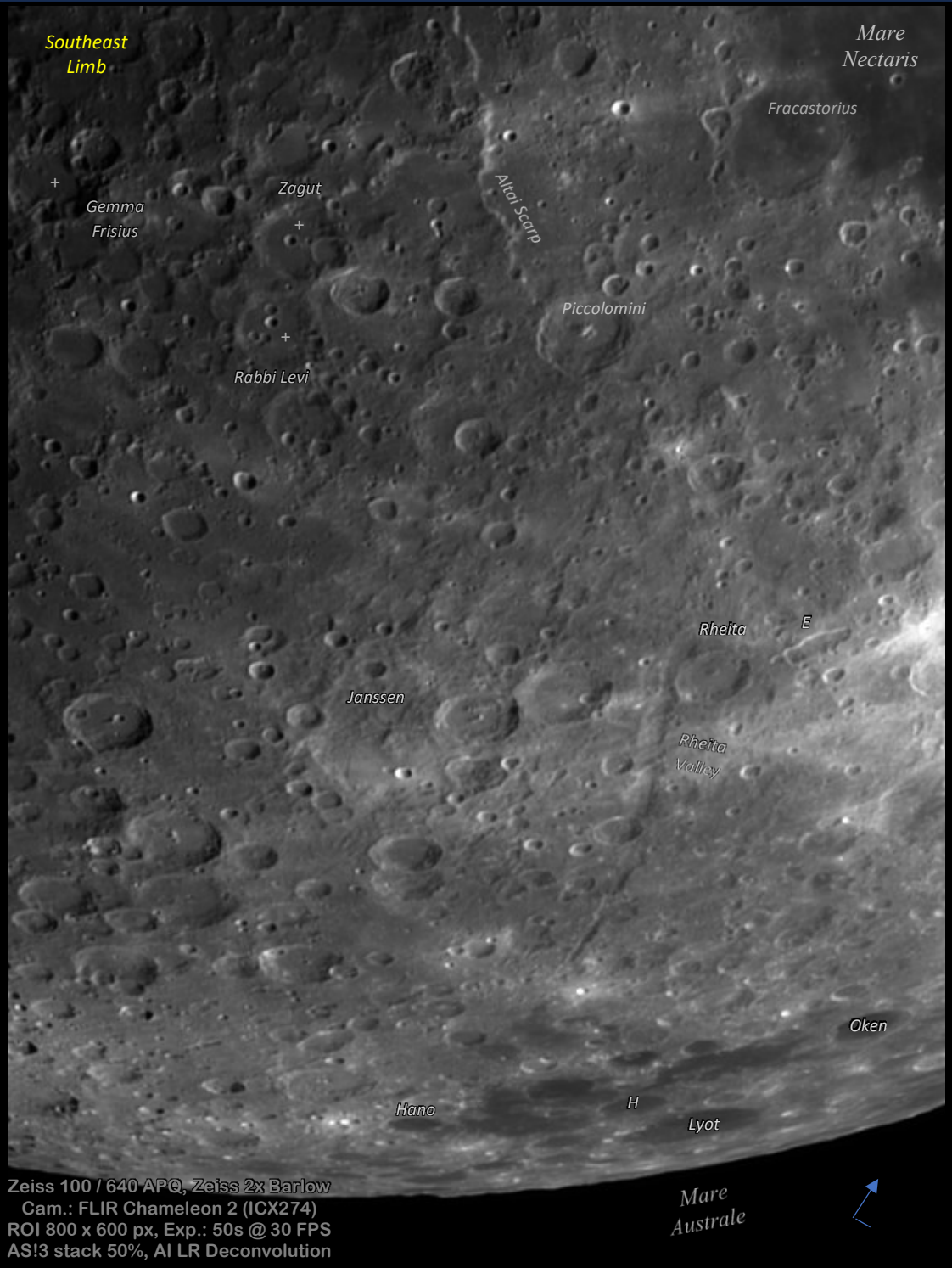
Zeiss 100 / 640 APQ, Zeiss 2x Barlow
Camera IMX183MM, ROI: 2752 x 2754 px
Exp.: 90s @ 30 FPS
AS!3 stack 25%, AI LR Deconvolution




Zeiss 100 / 640 APQ
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution
Mare Frigoris
Apennine Bench
Mare Serenitatis
Mare Tranquilitatis
Zeiss 100 / 640 APQ
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution
Great Peninsula


Zeiss 100 / 640 APQ, Zeiss 2x Barlow
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution
Cassini
Aristillus
Archimedes
Apennine Bench
Mare Serenitatis


Zeiss 100 / 640 APQ, Zeiss 2x Barlow
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution
Ptolemaeus
Hipparchus
Great Peninsula
Alphonsus
Arzachel
Albateginus
Purbach
La Caille
Deslandres
Blanchinus
Regiomontanus
Werner
Aliacensis
Walther
Stöfler



Zeiss 100 / 640 APQ, Zeiss 2x Barlow
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution

Zeiss 100 / 640 APQ, Zeiss 2x Barlow
Cam.: FLIR Chameleon 2 (ICX274)
ROI 800 x 600 px, Exp.: 50s @ 30 FPS
AS!3 stack 50%, AI LR Deconvolution