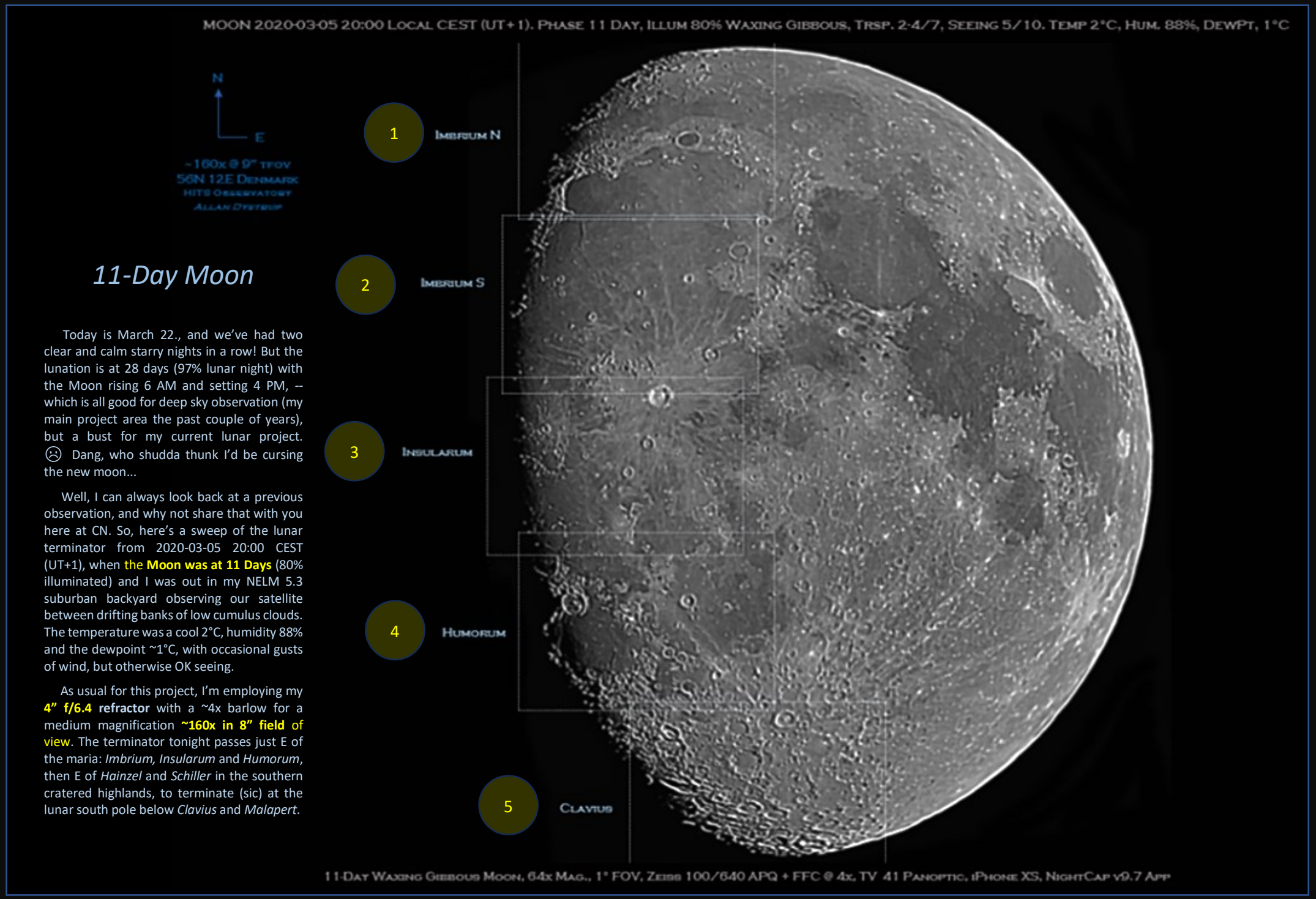
56N 12 E, Copenhagen DENMARK
2021-12-16 18:00 Local (UT+2)
Trsp.: 4-5/7, Seeing: 3-4/10 Windy

Zeiss 100/640 APQ,
500nm green bandpass filter
IMX183MM camera
Exp.: 100s @ 30 FPS
AS!3 30%, LR deconvolution



11-Day Moon

Today is March 22., and we've had two clear and calm starry nights in a row! But the lunation is at 28 days (97% lunar night) with the Moon rising 6 AM and setting 4 PM, -- which is all good for deep sky observation (my main project area the past couple of years), but a bust for my current lunar project. ☹ Dang, who shudda thunk I'd be cursing the new moon...

Well, I can always look back at a previous observation, and why not share that with you here at CN. So, here's a sweep of the lunar terminator from 2020-03-05 20:00 CEST (UT+1), when the **Moon was at 11 Days** (80% illuminated) and I was out in my NELM 5.3 suburban backyard observing our satellite between drifting banks of low cumulus clouds. The temperature was a cool 2°C, humidity 88% and the dewpoint ~1°C, with occasional gusts of wind, but otherwise OK seeing.

As usual for this project, I'm employing my **4" f/6.4 refractor** with a ~4x barlow for a medium magnification **~160x in 8" field** of view. The terminator tonight passes just E of the maria: *Imbrium, Insularum* and *Humorum*, then E of *Hainzel* and *Schiller* in the southern cratered highlands, to terminate (sic) at the lunar south pole below *Clavius* and *Malapert*.

11-Day Moon

1

11-Day Moon
Imbrium North

The **northern cratered highland** shows the usual layering of large, ancient pre-Nectarian craters (e.g. *Meton, W Bond, Goldschmidt, J Herschel* etc.), with younger Copernican rayed craters on top (*Anaxagoras*, *Philolaus*). The floors of some lower Imbrian craters (such as *Egede* and *Cassini*) and even the upper Imbrian crater *Plato* have been covered by lava in the late upper Imbrian magma flooding, which also created the maria: *Frigoris* and *Imbrium*. Later, the maria have been hammered by young impacts forming for example the Eratosthenian *Aristoteles* and the rayed Copernican crater *Aristillus*.

Plato shows the "Big Four" (2.1-2.7 Km Ø) craterlets A-B-C-D on the floor (and then some, such as the ~1.5 km Ø: g and f), plus the three sinuous lava channels [I-II-III] beyond the crater wall. The sinuous rilles at *Maupertuis* [M] and *Archytas* [A] are more difficult to spot (but can be glimpsed in moments of good seeing).

2

11-Day Moon
Imbrium South

The southern part of the **Imbrium Basin** is delimited by the mountain ranges: *Montes Carpatus* and *Montes Apenninus*; Inside this excavation boundary is seen to the east the arcuate *Montes Archimedes*, which is a remnant of the inner Imbrium basin ring residing on the Apennine Bench. Some craters on the Imbrian basin floor (*Archimedes*, *Wallace*) were almost drowned when the basin filled up with mare lava in late upper Imbrian (with the exception of the uplifted Apennine Bench). A few lava channels (*Rima Euler* [E]) and volcanic domes (*Gruithuisen* [γ, δ]) can be spotted towards the shore of Mare Imbrium.

Later **Eratosthenian impacts** have cratered the mare lava surface, notably *Eratosthenes* itself, but also a line of craters: *Timocharis, Lambert* and *Euler*.

Finally, the young Copernican crater **Copernicus** has thrown out a giant ejecta carpet with chains of secondary craters plus a massive spider web of white rays reaching way up north into S. Imbrium and also far down south across Insularum (see my overview iPhone image at 64x magnification a couple of posts back in this thread).

3

11-Day Moon
Insularum

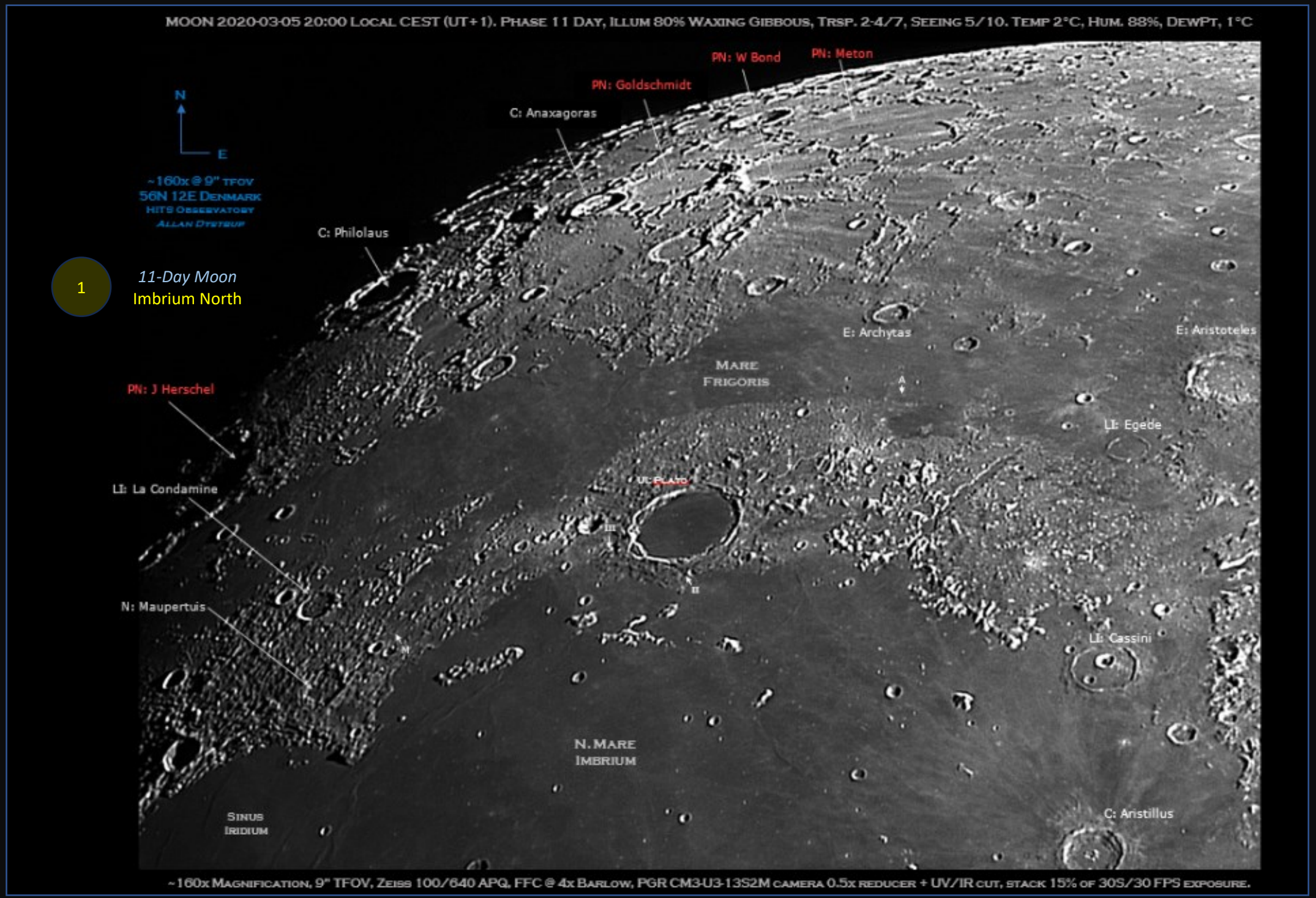
Panning down south now, to the region S of the *Montes Carpatus* part of the Imbrium Basin rim; In the upper part of the field of view is the **trough beyond the Imbrium excavation boundary**, which further south gradually transits into the **E part of the Procellarum Basin**.

There are some rough **highland plains** in this field, which were thought to be of volcanic origin, but Apollo 14 rock samples (impact shocked breccias) from the plains north of *Fra Mauro* revealed these to be pre-Imbrian crust covered by a blanket of debris and melt ejected by the Imbrium Basin impact.

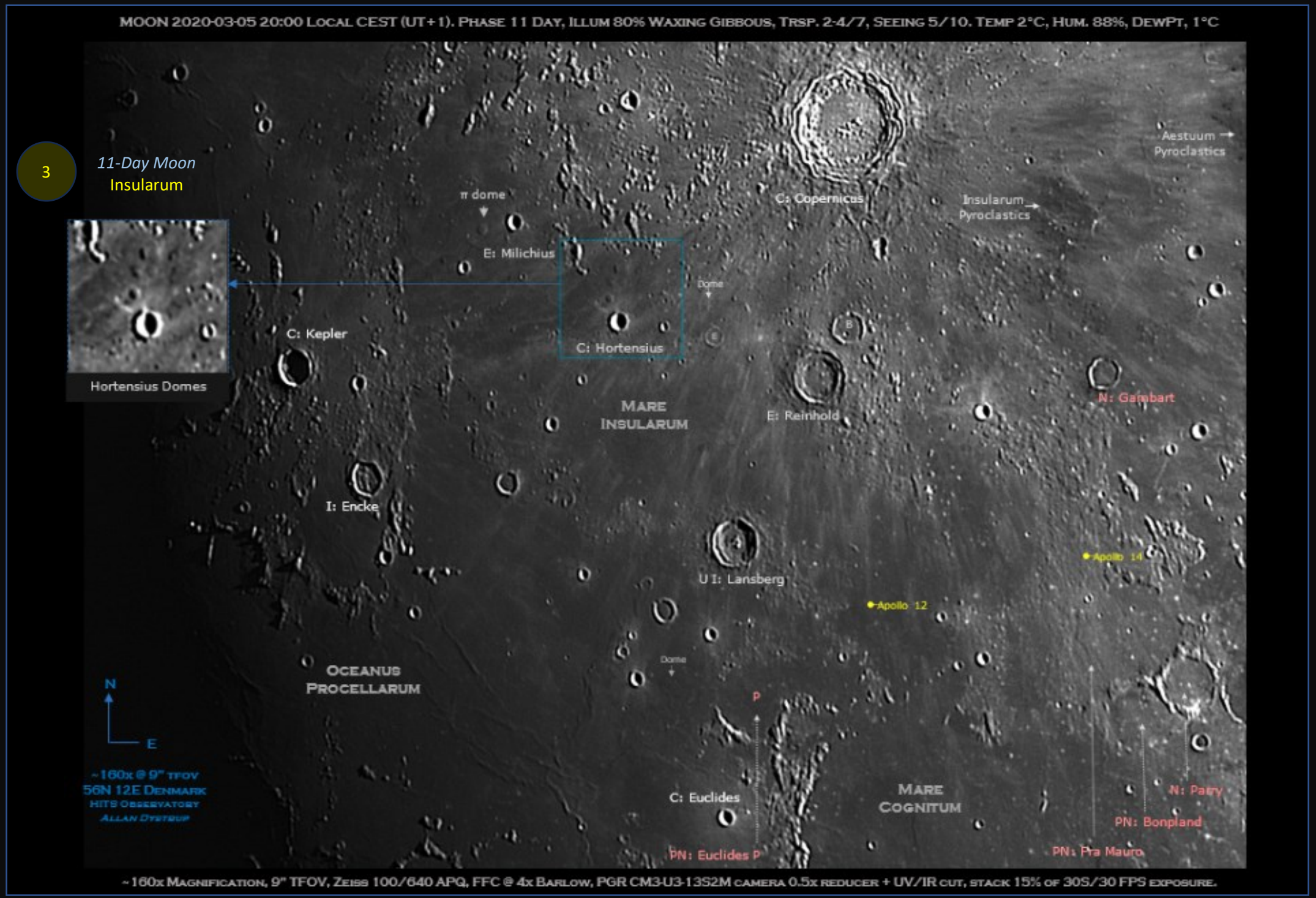
The area has been extensively **flooded in the upper Imbrian and later Eratosthenian lava flows**, embaying the highland plains and leaving only traces of ancient pre-Nectarian (*Fra Mauro, Bonpland, Euclides P*) and Nectarian (*Gambart, Reinhold B, Parry*) craters. Some of the lava puddles have received separate names: *Aestuum, Insularum, Cognitum, Nubium*, -- but at least *Aestuum* and *Insularum* are probably not separate impact basins, but rather flooded low-lying regions created by other impacts.

The upwelling magma has fractured the floor in some craters (*Encke*), and was accompanied both by explosive **fire fountain volcanism** creating large patches of dark pyroclastic deposits (*Aestuum, Insularum*), and also by more quiet eruptions leaving **shield domes** with summit pits such as the *π Milichius* dome, the *Hortensius domes* and several others.

The recent large **Copernicus impact** of course dominates the view, with its central peaks, hummocky floor and bright terraced walls surrounded by a ring of impact melt and a far-flung web of crushed highland rock stretched out in bright rays across the dark mare lava of *Insularum, E Procellarum* and *Cognitum*. The landing site of Apollo 12 was selected to be right on top of one such Copernicus ray, in the hope of sampling both old pre-Nectarian bedrock material and younger mare lava. The sampled mare basalt was indeed younger than the Apollo 11 Tranquility Base mare by ~0.5 Byr (borderline Eratosthenian/Imbrian: 2.3 Byr) and the Copernicus ray material was ~0.8 Byr, which provided a good dating of the Copernicus impact.


MOON 2020-03-05 20:00 LOCAL CEST (UT+1). PHASE 11 DAY, ILLUM 80% WAXING GIBBOUS, TRSP. 2-4/7, SEEING 5/10. TEMP 2°C, HUM. 88%, DEWPT, 1°C
N
E
~160x @ 9" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYTTERUP
1
11-Day Moon
Imbrium North
PN: W Bond
PN: Meton
PN: Goldschmidt
C: Anaxagoras
C: Philolaus
E: Archytas
E: Aristoteles
MARE FRIGORIS
PN: J Herschel
LI: Egede
LI: La Condamine
LI: Cassini
N: Maupertuis
N. MARE IMBRIUM
SINUS IRIDIUM
C: Aristillus
~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 30S/30 FPS EXPOSURE.


MOON 2020-03-05 20:00 LOCAL CEST (UT+1). PHASE 11 DAY, ILLUM 80% WAXING GIBBOUS, TRSP. 2-4/7, SEEING 5/10. TEMP 2°C, HUM. 88%, DEWPT, 1°C
Promontorium Heraclides
I: Archimedes
Gruithuisen γ & δ
Mts. Archimedes
Apennine Bench
E: Timocharis
E: Lambert
I: Wallace
S. MARE IMBRIUM
Mts. Harbinger
E: Euler
C: Pytheas
Mts. Apenninus
E: Eratosthenes
E
Mts. Carpatus
C: Copernicus Ejecta Carpet
2
11-Day Moon
Imbrium South
N
E
~160x @ 9" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYBTSRUP
~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 30S/30 FPS EXPOSURE.


MOON 2020-03-05 20:00 LOCAL CEST (UT+1). PHASE 11 DAY, ILLUM 80% WAXING GIBBOUS, TRSP. 2-4/7, SEEING 5/10. TEMP 2°C, HUM. 88%, DEWPT, 1°C
3
11-Day Moon
Insularum
Hortensius Domes
π dome
E: Milichius
C: Copernicus
Aestuum Pyroclastics
Insularum Pyroclastics
Dome
C: Kepler
C: Hortensius
MARE INSULARUM
E: Reinhold
N: Gambart
I: Encke
U I: Lansberg
Apollo 14
Apollo 12
OCEANUS PROCELLARUM
Dome
P
N
E
~160x @ 9" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYETRUP
C: Euclides
MARE COGNITUM
N: Patry
PN: Bonpland
PN: Euclides P
PN: Pra Mauro
~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 30S/30 FPS EXPOSURE.

4

11-Day Moon
Humorum

Moving further south along the 11-day terminator, I now place the **Humorum Basin** towards the SW, with the **Nubium region** up NE; *Nubium* may be an ancient pre-Nectarian basin, but if so, it is far from well defined (the scarp/ridge *Rupes Mercator* could be what's left of the SW excavation rim?).

The whole area has been **lava flooded in the upper Imbrian and Eratosthenian** epochs, with the basalt in the *Humorum Basin* forming a deep mare showing an inner wrinkle ridge ring plus a clear excavation rim, complete with subsidence scarps (*Liebig*), arcuate rilles (*Hippalus*) and floor fractured craters at the shores (*Gassendi, Vitello*).

In contrast the **Nubium region** only has a shallow lava covering, with the (sometimes only partial) rims of many Nectarian craters still protruding (*Opelt, Gould, Lubiniezky, Agatharchides, Wolf, Pitatus, Hesiodus*...). The Rimae along the inner wall of Pitatus were probably created by magma intrusion that flooded and uplifted the crater floor at the shore of Nubium. A few mare stretch-marks can be seen in the Nubium area (*Rimae Hesiodus, Agatharchides*), and also some volcanic formations, most prominent the *Agatharchides Megadome* ("The Helmet"), the *φ dome* at Kies crater and the dome located inside the lava flooded crater *Capuanus*.

Bullialdus is a striking (sic) early Eratosthenian impact in the new-formed shallow mare surface of S Nubium; It is surrounded by a ring of impact melt and an ejecta carpet rich in mare basalt (any light rays of deeper bedrock anorthosite have faded by now).

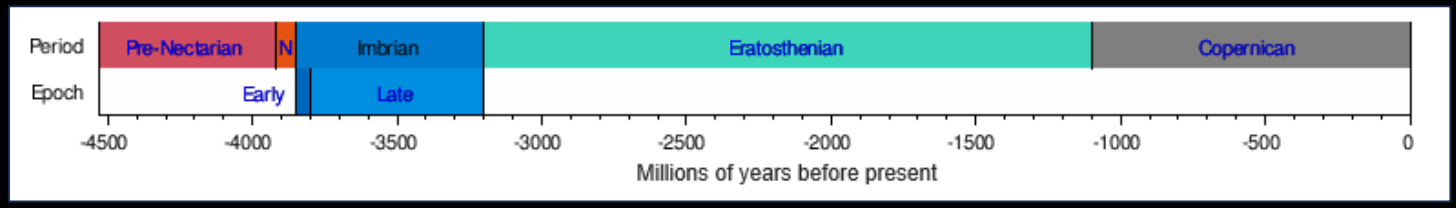
5

11-Day Moon
Clavius

Ending my sweep along the 11-day lunar terminator, I arrive once more at the **Southern Cratered Highlands**, now with the large crater "diamond" of *Tycho-Longomontanus-Maginus-Clavius* well lit up at the center, and the "unusual" pair of craters *Hainzel-Schiller* towards the terminator at the W. I've described these mostly old (pre-)Nectarian craters before, so tonight I'll focus on the area around the S. Pole.

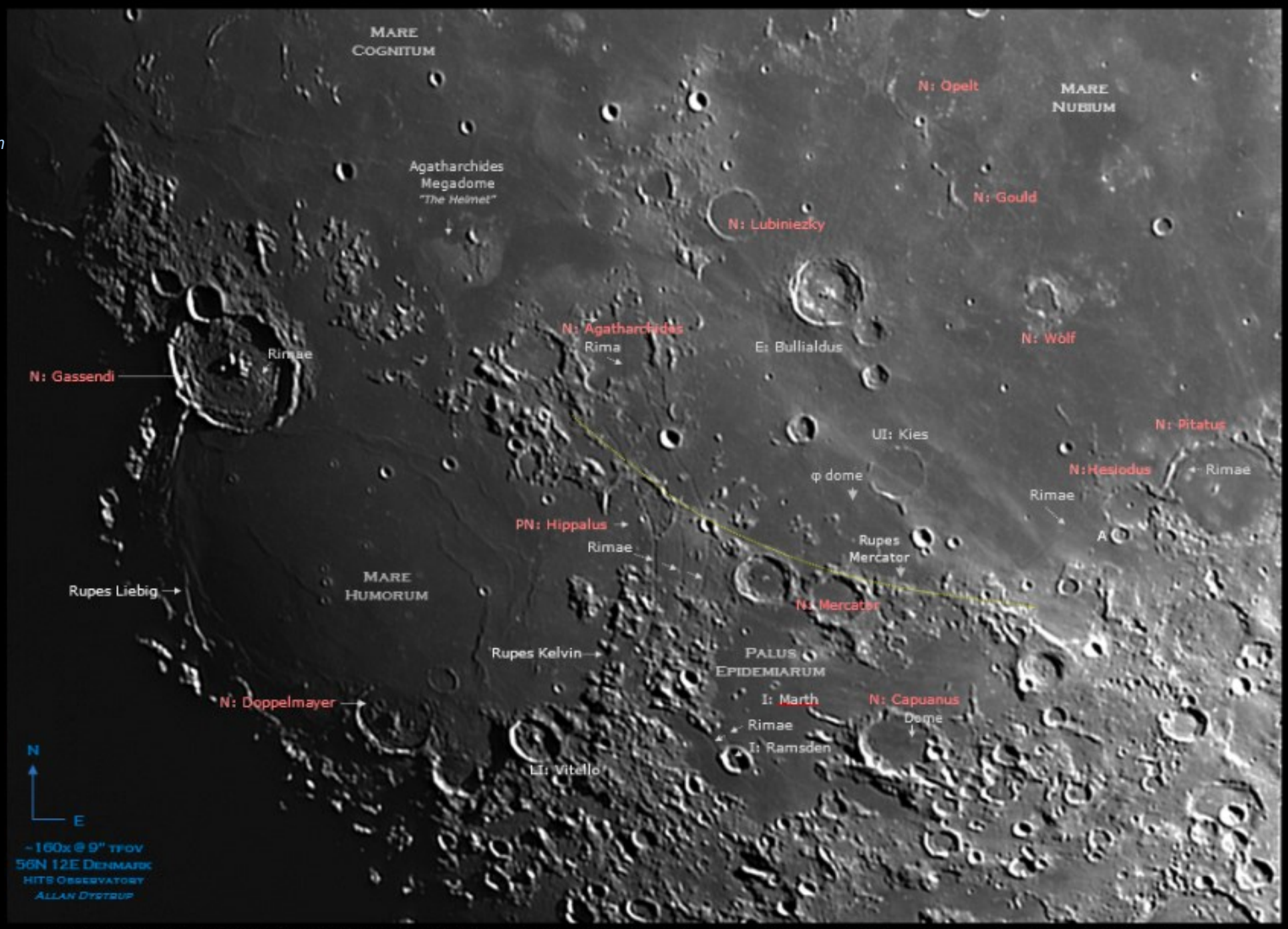
The far **South Polar Region** is also dominated by old pre-Imbrian impacts: from *Bettinus* and *Kircher* towards the SW all along the lunar rim to *Scott* and *Amundsen* at the SE. There are two relatively young craters in the south cratered highlands: Copernican *Tyco* and Eratosthenian *Moretus*, and if you draw a line through the centers of these craters and extend it to the lunar limb, you arrive at the ancient pre-Nectarian crater *Malapert*.

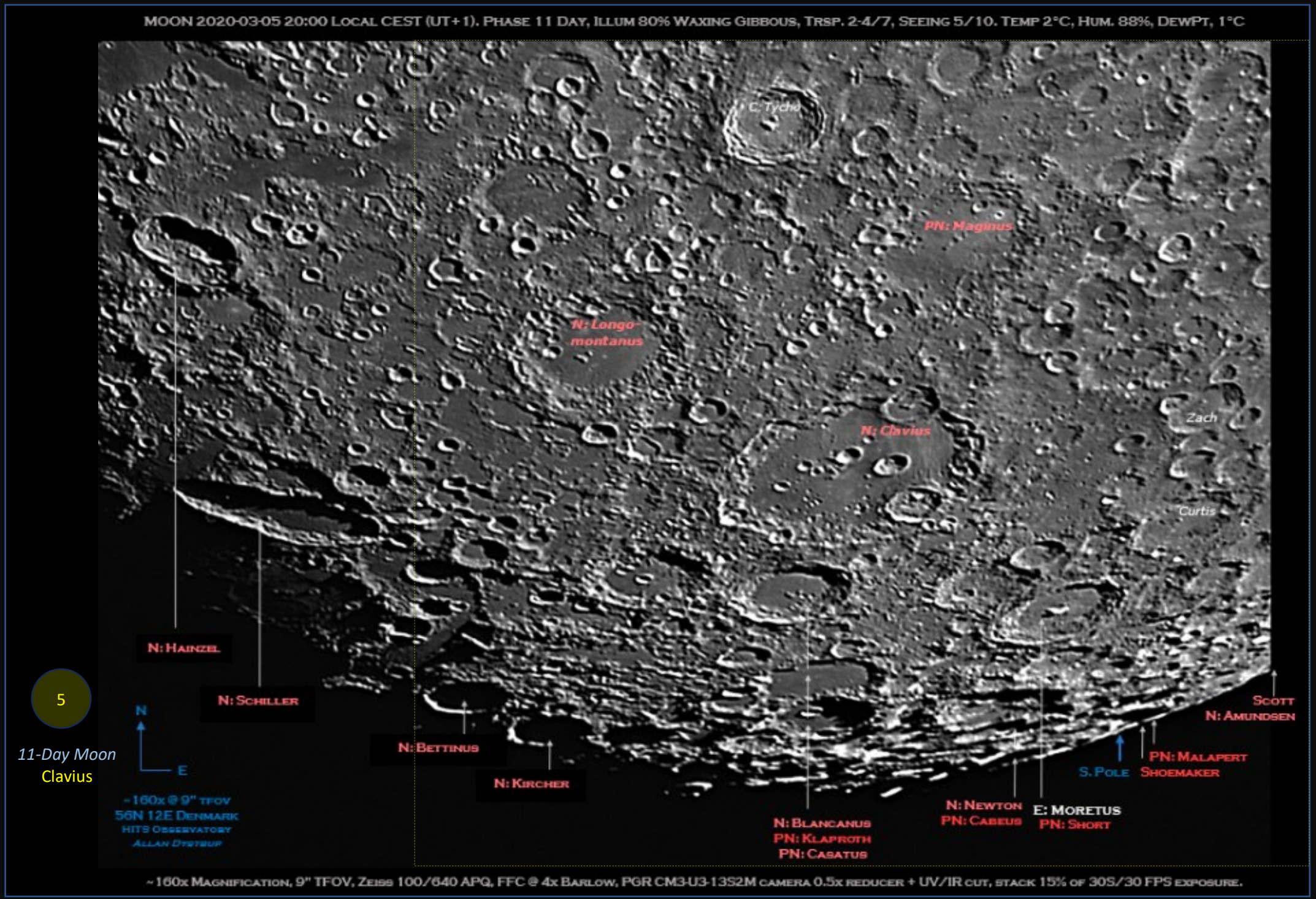
The latitudinal libration tonight is -1°, so not really favorable for zooming in on the exact location of the S. Pole, -- but I can see the **Malapert Mountain ridge** between *Malapert* and *Shoemaker* to the S. This ridge rises to a height of 5 km with the peak at ~0° longitude, having the N side always in sunlight while the S side facing *Shackleton* crater at the S. Pole is in perpetual darkness. *Mt. Malapert* has been proposed as the target site for a lunar expedition to the S. Pole, with the near side providing continuous solar power and radio communication, while the far side can provide possible water resources, and would also be ideal for radio astronomy, shielded from Earths radio noise.

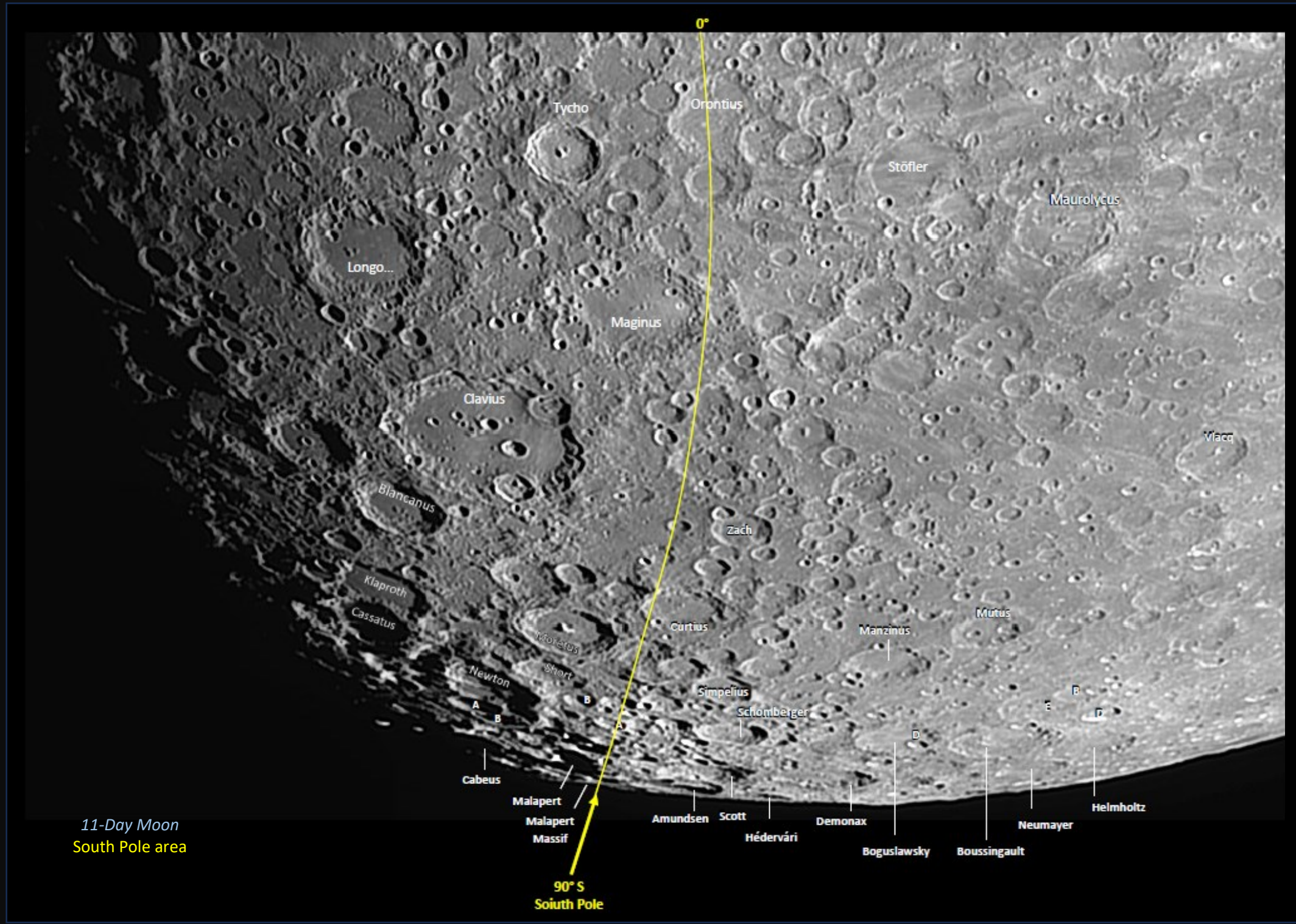


4

11-Day Moon
Humorum




MOON 2020-03-05 20:00 LOCAL CEST (UT+1). PHASE 11 DAY, ILLUM 80% WAXING GIBBOUS, TRSP. 2-4/7, SEEING 5/10. TEMP 2°C, HUM. 88%, DEWPT, 1°C
C. Tycho
PN: Maginus
N: Longo-montanus
N: Clavius
Zach
Curtis
N: HAINZEL
N: SCHILLER
N: BETTINUS
N: KIRCHER
N: BLANCANUS
PN: KLAPROTH
PN: CASATUS
N: NEWTON
PN: CABEUS
E: MORETUS
PN: SHORT
S. POLE
PN: MALAPERT
SHOEMAKER
SCOTT
N: AMUNDSEN
N
E
~160x @ 9" TFOV
56N 12E DENMARK
HITS OBSERVATORY
ALLAN DYRSKJØP
5
11-Day Moon
Clavius
~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 30S/30 FPS EXPOSURE.



11-Day Moon
South Pole area

11 DAY MOON

1

11-Day Moon
Imbrium

2

11-Day Moon
Copernicus

11 - DAY MOON

2021-04-22, 20:45 Local DST (UT+2)
Temp.: 1°C, Hum.: 60%, Vind: 15-20 Km/h
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10

Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus, ROI 2752x2754
150s @ 30 FPS, AS!3 stack 50%
AI Deconvolution & Tone

11-Day Moon

The gigantic ***Procellarum* impact basin** formed ~4.3 Gyr ago (pre-Nectarian) in the residual melt from the ancient Lunar Magma Ocean; This melt is characterized by a high content of Potassium/Kalium, Rare Earth Elements and Phosphorus ("KREEP"). Later, ~3.9 Gyr ago, the smaller lunar basins formed during the heavy bombardment, and in the following 3.8-3.2 Gyr (Late-Imbrian) period, the basins were filled with low-Titanium lava flows from the then still partially melted lunar mantle.

1

11-Day Moon
Imbrium

Imbrium is the largest of the well-preserved lunar basins, and it was formed on the *Procellarum* KREEP-rich terrane, parts of which was excavated and deposited in the basin rim ejecta (as sampled on the *Apennine Bench* by Apollo 15 at the *Hadley Rille*). Three later lava flows with increasing levels of Titanium have occurred on top of the thick early Imbrium lava cover, -- all originating from volcanic shield eruptions in a small area SW of the crater **Euler** and from here flowing up NE towards the **Helicon** crater :

I: *Late Imbrian flow* (3.0 Gyr) up to 10m thick and extending 1200 km
II: *Early Eratosthenian flow* (2.7 Gyr) 15-25m thick and extending 600 km
III: *Middle Eratosthenian flow* (2.5 Gyr) 25-60m thick and extending 400 km

The source region for these (relatively) young lava sheets is located where the second Imbrium basin ring crosses a fraction line around the Copernicus crater, possibly providing crust fissures/conduits for low-viscosity and fast extrusion-rate lava flows, which can still be identified as cones/vents (*Mt. Vinogradov*), channels (*Rima Euler*), levees and flow fronts (for the II and III lava fields, e.g. around Mt. La Hire).

Below is shown **the** 11-day waxing gibbous moon with Mare Imbrium framed. In the following image is shown a zoom-in / crop of the Mare Imbrium region, and the next image is annotated with the **young phase I-II-II lava flows** emanating from the **Euler fracture region** and extending up NE past **Mt. La Hire** towards the Helicon crater.

11-Day Moon, 4" f/6.4 prime focus full disc and full resolution:
https://www.flickr.com/photos/139500911@N04/51139568008/in/datetaken-public/

The Moon was well up above the horizon (40° Alt.) and both seeing and transparency were around medium. The time was late afternoon bordering on civil dusk ('golden hour') with a still blue daylight sky, so I used a green longpass filter for better contrast. The result is only "so-so" for finer details, but I'm having a busy spring with garden, building and family projects, so I have to work with what opportunities I get for astronomy.

Euler and Mt. La Hire volcanic features

The mountainous area SW of Euler ('Natasha Hills') may be the remains of a slump terrasse that slid down during a collapse of the Imbrium basin rim (i.e. from the Carpathian Mts., -- much like the Archimedes Mts. Slide at the Apennine Bench); More recent topographic investigations (LRO, Kaguya, Clementine) have revealed that the **young Mare Imbrium lava flows** show well defined flow margins, levees and channels that are traceable back to a source region SW of Euler crater.

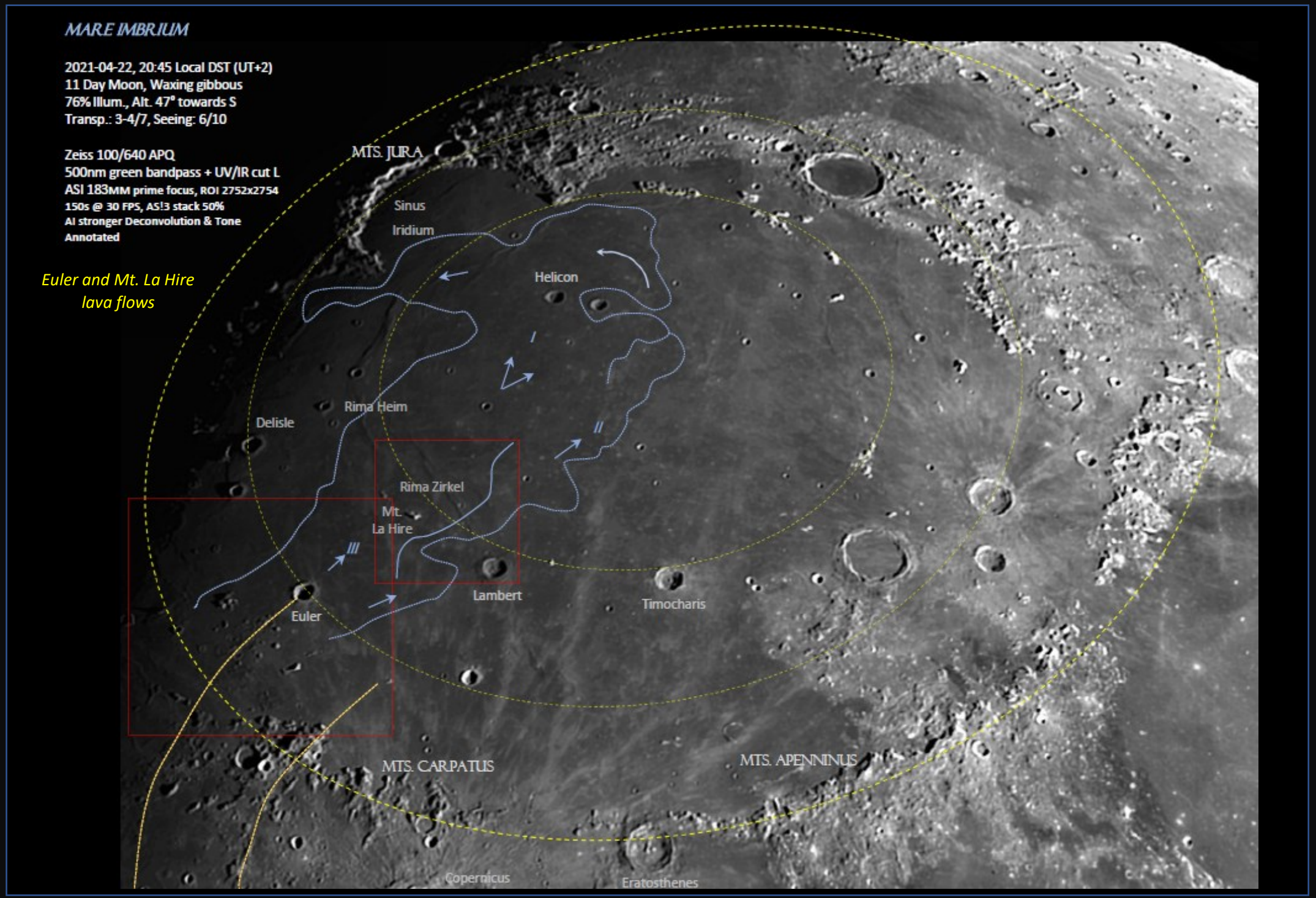
Around *Mt. La Hire* the phase II and III lava flows converge, showing sheets with lobate margins and channels surrounded by levees. These morphologies cannot be clearly seen on my zoomed-in image crop below, -- the resolution is simply not high enough due to my limited (4") aperture and the mediocre seeing this afternoon. I have however included a LROC:QuickMap transect from the area just SE of Mt. La Hire, displaying a cross section of several lava channels with surrounding levees.

The *region SW of Euler shows* several features of volcanic origin: domes with central pits, lava channels (rimae) and lava tubes with collapsed roofs. I've marked a couple of domes plus the position of the Euler rilles on my image below. These were all hard to spot during my observation, but I'll try again under better observing conditions. I include a 3D view of the dome with central pit, which I've indicated as #1 on my image. This view (3x height exaggerated) was created using the LROC:QuickMap application.

MARE IMBRIUM CROP
11 – DAY MOON

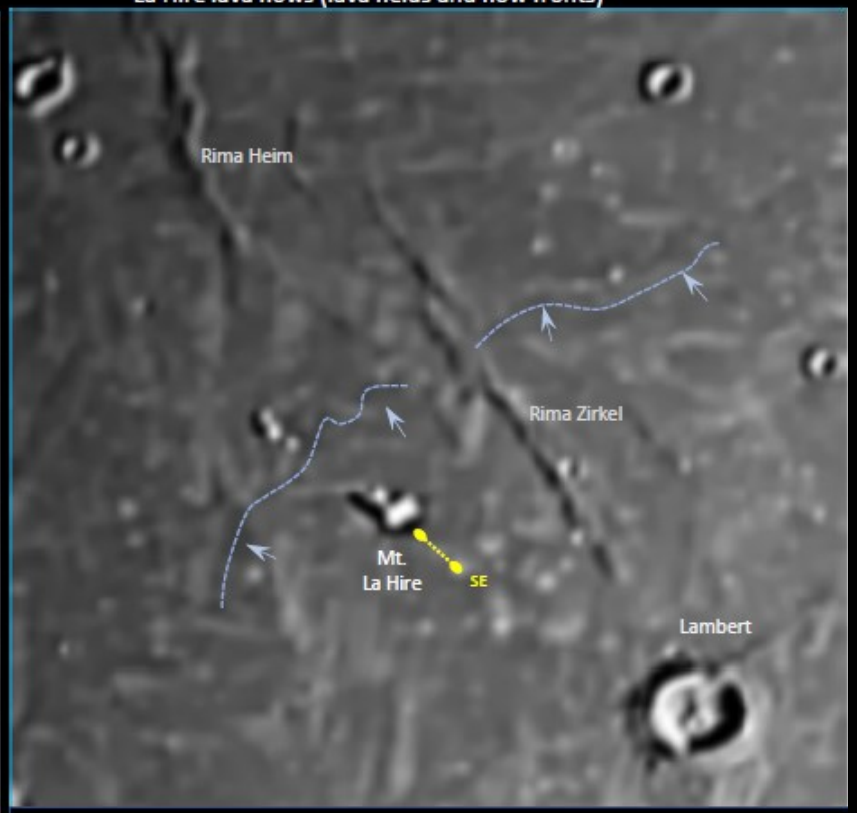
2021-04-22, 20:45 Local DST (UT+2)
Temp.:1°C, Hum.:60%, Vind:15-20 Km/h
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10

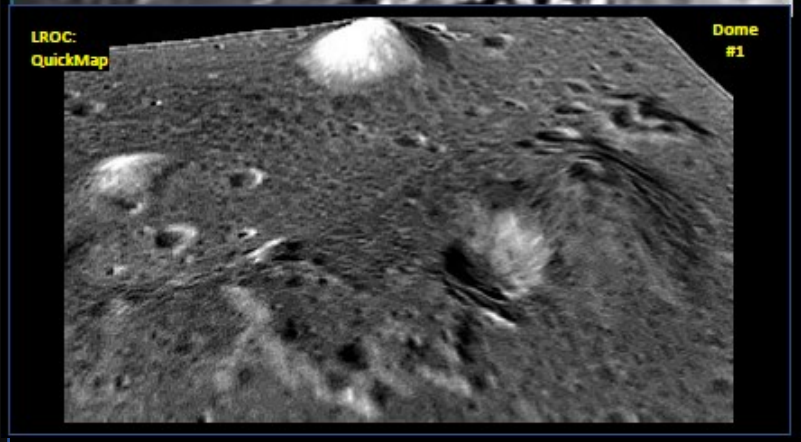
Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus, ROI 1024x768
100s @ 30 FPS, AS!3 stack 75%
AI Deconvolution & Tone

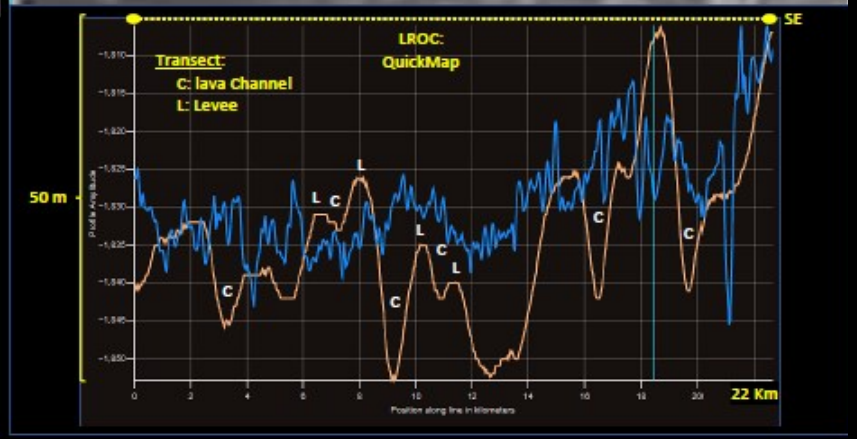

MARE IMBRIUM
2021-04-22, 20:45 Local DST (UT+2)
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10
Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus, ROI 2752x2754
150s @ 30 FPS, AS!3 stack 50%
AI stronger Deconvolution & Tone
Annotated
Euler and Mt. La Hire lava flows
MTS. JURA
Sinus Iridium
Helicon
Rima Heim
Delisle
Rima Zirkel
Mt. La Hire
Lambert
Euler
Timocharis
MTS. CARPATUS
MTS. APENNINUS
Copernicus
Eratosthenes

Source region for late Imbrian/Eratosthenian lava flows (I-II-III

La Hire lava flows (lava fields and flow fronts)







Euler and Mt. La Hire volcanic features

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2

11-Day Moon
Copernicus South

Insularum is the common name for the lava-covered trench bordering the Imbrium Basin rim (3.8 Gyr) towards the south, i.e. S of the *Carpathian* and *Apennine Mountain* ranges. The Insularum mare lavas (age ~3.6 Gyr) were partly covered by dark mantle deposits (DMD): fine volcanic ash from explosive "fire fountain" eruptions, stretching from the E shores of Sinus Aestuum across eastern Mare Insularum.

Later, a large young impact (<1.1 Gyr) created the magnificent 93 km wide Copernicus crater on top of the dark lava and ash deposits, complete with central crater peaks, a 1 km high rim surrounded by a large ejecta carpet with chains of secondary craters and a light hued web of ejecta rays. The young, small crater *'Copernicus H'* has dug through the ejecta carpet S of Copernicus, down to the underlying DMD-layer, leaving a dark halo around the crater.

2a

11-Day Moon
Crop: Mare Insularum S.
Apollo Missions

After the Apollo 11 mission to the eastern old *Mare Tranquilitatis*, the following two successful Apollo missions (12 and 14) were designated to explore the younger mare region (12) and an ejecta blanket (14), both in the central equatorial region of the Moon.

Apollo 12 touched down 370 Km S of *Copernicus* on a bright ejecta ray from the young Copernicus impact; The samples collected from this site showed that the dark mare basalts in *S Insularum* were 500 Myr younger than Mare Tranquilitatis, and that the ejecta ray material could date the Copernicus impact to only ~850 Myr ago.

Apollo 14 landed 500 Km S of the Imbrium Basin rim (Mts. Apenninus) on a rough ejecta carpet from this impact containing smoother patches, which were thought could be of volcanic origin; Analysis of the collected samples from the blanket of debris however, showed no volcanic basalts, but rather complex breccias, including some excavated pre-Imbrium (3.9 Gyr) rocks and some conglomerates containing melt from the Imbrium impact (3.8 Gyr).

2b

11-Day Moon
Crop: Mare Insularum NW.
Dome land.

The oldest massive lavas flows formed the maria Tranquilitatis and Serenitatis (3.8-3.6 Gyr, high TiO_2, Apollo 11 and 17), younger lavas pooled up in Imbrium, Fecunditatis and Crisium (3.6-3.2 Gyr, lower TiO_2, Luna 16 and 24) , whereas the youngest lava flows have formed a thin cover on parts of Mare Imbrium and Procellarum (~2 Gyr Eratosthenian, Apollo 12).

In the wake of these giant low viscosity lava floods, the outer mantle cooled, the eruptive lava extrusion rate decreased, subsurface crystallizing lava pushed up dikes and domes and piled up around vents forming low shield volcanoes, often with magma withdrawal resulting in a central pit and subsequent vent collapse. Good examples of Eratosthenian Lunar mare dome fields are seen in western Mare Insularum: NW of the crater Milicius and NE of the crater Hortensius.

COPERNICUS SOUTH

2021-04-22, 20:45 Local DST (UT+2)
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10

Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus, ROI 800x600
100s @ 30 FPS, AS!3 stack 75%
AI stronger Deconvolution & Tone
Annotated

2b

11-Day Moon -- Crop
Mare Insularum NW.
Dome land

- The oldest **massive lavas flows** formed the maria *Tranquilitatis and Serenitatis* (3.8-3.6 Gyr, high TiO2, Apollo 11 and 17),
- younger lavas pooled up in *Imbrium, Fecunditatis and Crisium* (3.6-3.2 Gyr, lower TiO2, Luna 16 and 24) , whereas
- the youngest lava flows have formed a thin cover on parts of *Mare Imbrium and Procellarum* (~2 Gyr Eratosthenian, Apollo 12).

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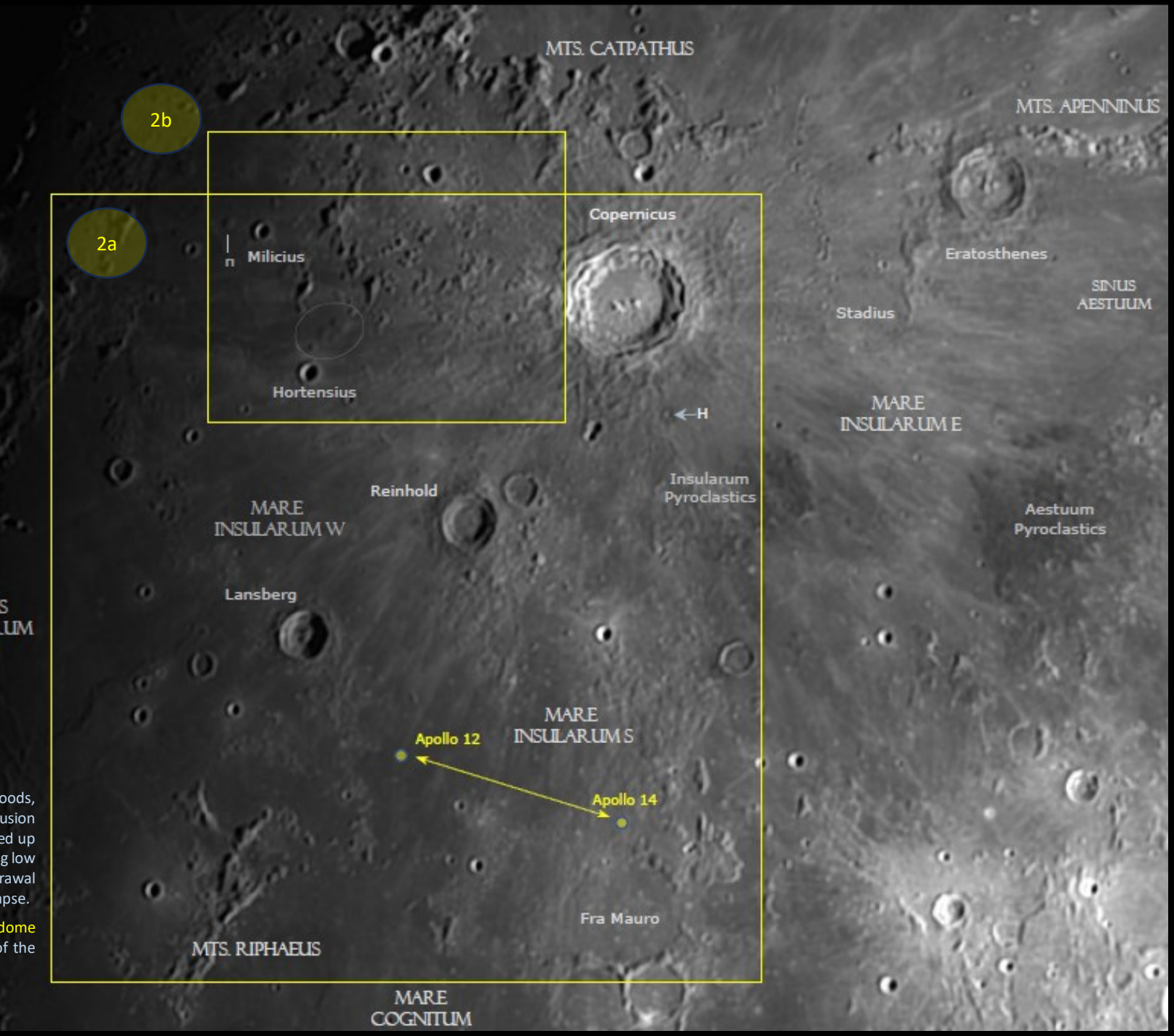
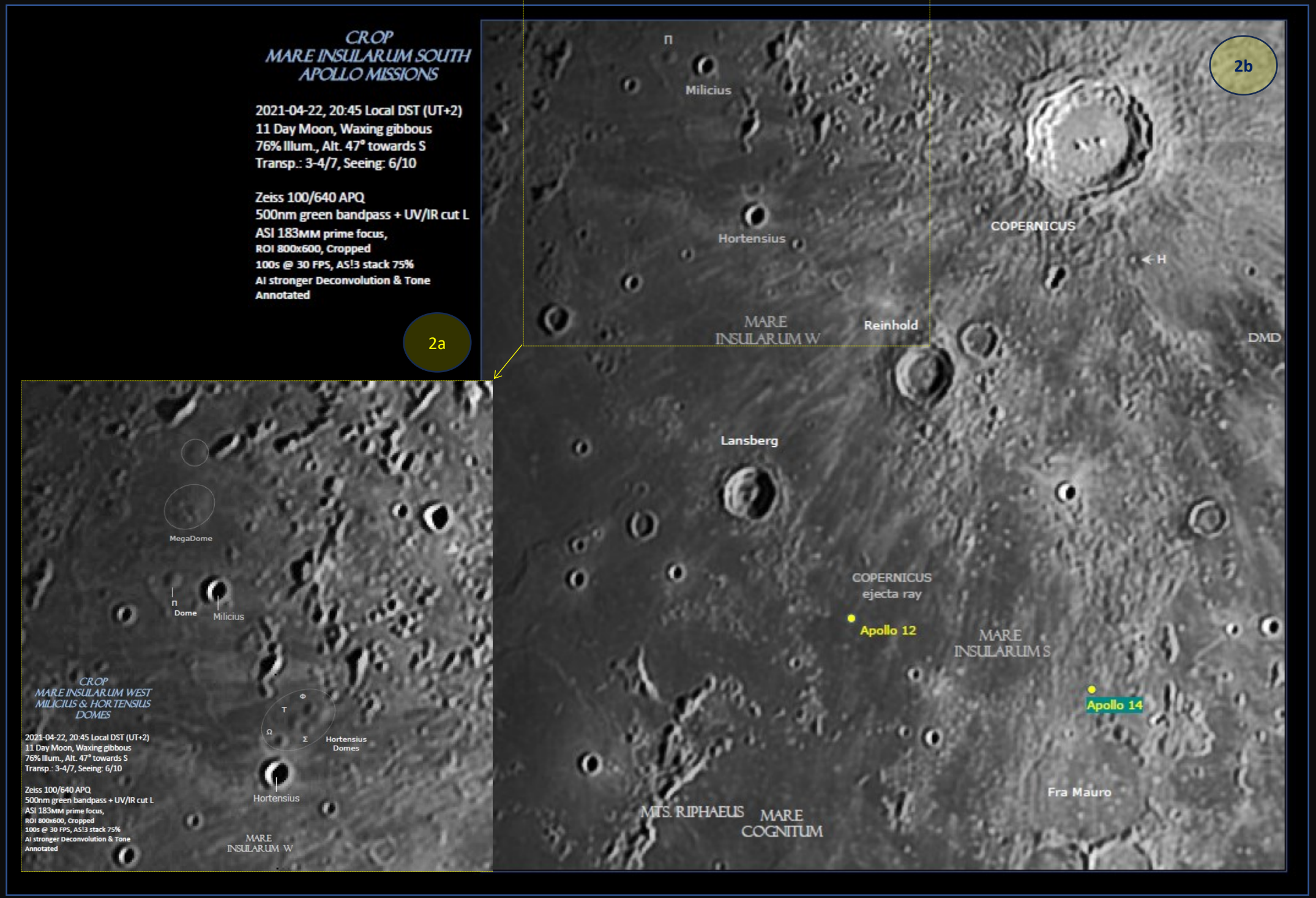
Good examples of Eratosthenian Lunar mare dome fields are seen in western Mare Insularum: NW of the crater Milicius and NE of the crater Hortensius.




CROP
MARE INSULARUM SOUTH
APOLLO MISSIONS
2021-04-22, 20:45 Local DST (UT+2)
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10
Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus,
ROI 800x600, Cropped
100s @ 30 FPS, AS!3 stack 75%
AI stronger Deconvolution & Tone
Annotated
2a
2b
Milicius
Hortensius
COPERNICUS
H
MARE
INSULARUM W
Reinhold
DMD
Lansberg
MegaDome
Dome
Milicius
CROP
MARE INSULARUM WEST
MILICIUS & HORTENSIUS
DOMES
2021-04-22, 20:45 Local DST (UT+2)
11 Day Moon, Waxing gibbous
76% Illum., Alt. 47° towards S
Transp.: 3-4/7, Seeing: 6/10
Zeiss 100/640 APQ
500nm green bandpass + UV/IR cut L
ASI 183MM prime focus,
ROI 800x600, Cropped
100s @ 30 FPS, AS!3 stack 75%
AI stronger Deconvolution & Tone
Annotated
Hortensius
Domes
Hortensius
MARE
INSULARUM W
COPERNICUS
ejecta ray
Apollo 12
MARE
INSULARUM S
Apollo 14
Fra Mauro
MTS. RIPHAEUS
MARE
COGNITUM

12-Day MOON

56N 12 E, Copenhagen DENMARK
2021-12-16 18:00 Local (UT+2)
Trsp.: 4-5/7, Seeing: 3-4/10 Windy

Zeiss 100/640 APQ,
500nm green bandpass filter
IMX183MM camera
Exp.: 100s @ 30 FPS
AS!3 30%, LR deconvolution

12 DAY WAXING GIBBOUS MOON

It's the end of August, just around midnight local time (2020-08-30/31, 23.00-01.00 DST CEST (UT+2). The 12-Day 95% waxing gibbous moon is hanging at a low 11.9° altitude in Capricorn, just past the meridian towards the S horizon. Here at 56°N 12E in Denmark we are now crossing the border from Summer to Autumn, with a fresh temperature of 13°C, 80% humidity and the dew-point down at 9°C. The seeing is a bit wavering around 4-5/10 and the transparency is ~medium at 4-5/7, with a faint halo around the moon from the high atmospheric humidity plus a sheet of medium-altitude stratocumulus stratiformis covering half the night sky (but not the moon, currently).

I'm out, barefoot and in shirtsleeves, in my Copenhagen suburban backyard with the 7" f/10 Mak telescope for a closer look at the lunar terminator: from Mare Frigoris, further on through the E Procellarum area with the Aristarchus plateau and the Marius hills, and down to the cratered southern highlands with the large prominent Schickard crater. The full disc view is pretty good at low magnification, using a 2x barlow plus a 41mm Panoptic for 88x, but it gets softer as I push up the magnification to 140x with my small ASI120MC camera.

LUNAR LAVAS.

It's interesting to play with the color saturation on a view of the (almost) full moon, if you look at it through a color sensitive camera; This can bring out subtle differences in the albedo and hue that reflect (so to speak) the age and chemical composition of the lava basalt sheets of the lunar maria.

For example:

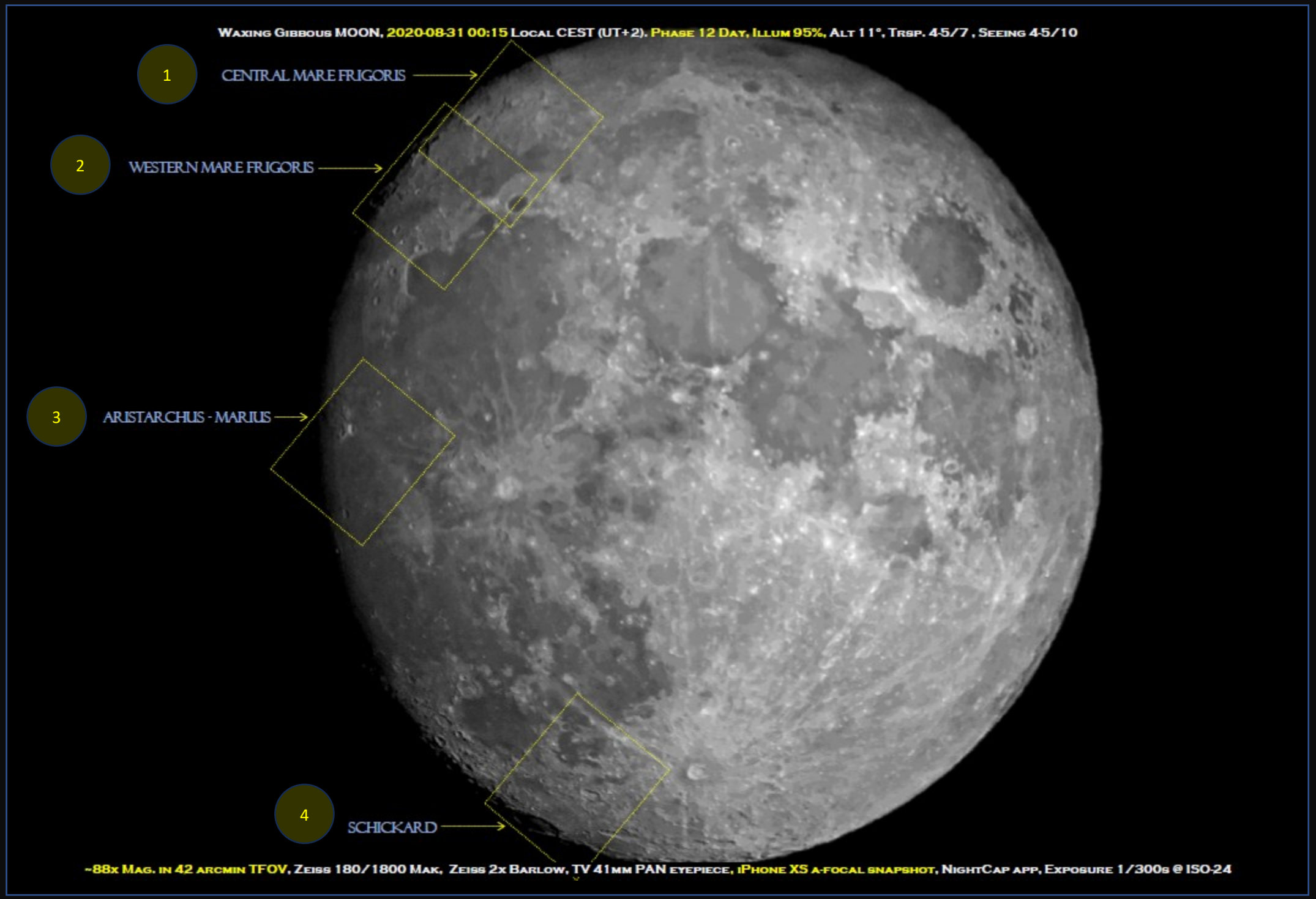
- E Imbrium, central Serenitatis and Crisium are all covered by young, light hued red-ish (low titanium) lavas from the late upper Imbrium epoch, while
- Sinus Iridium, the shores of Serenitatis plus Tranquilitatis show older and darker higher-aluminum lavas from middle Upper Imbrium.
- Finally, central Frigoris (and Plato), Central Imbrium and NE Procellarum all show a young middle-hued Eratosthenian lava covering.

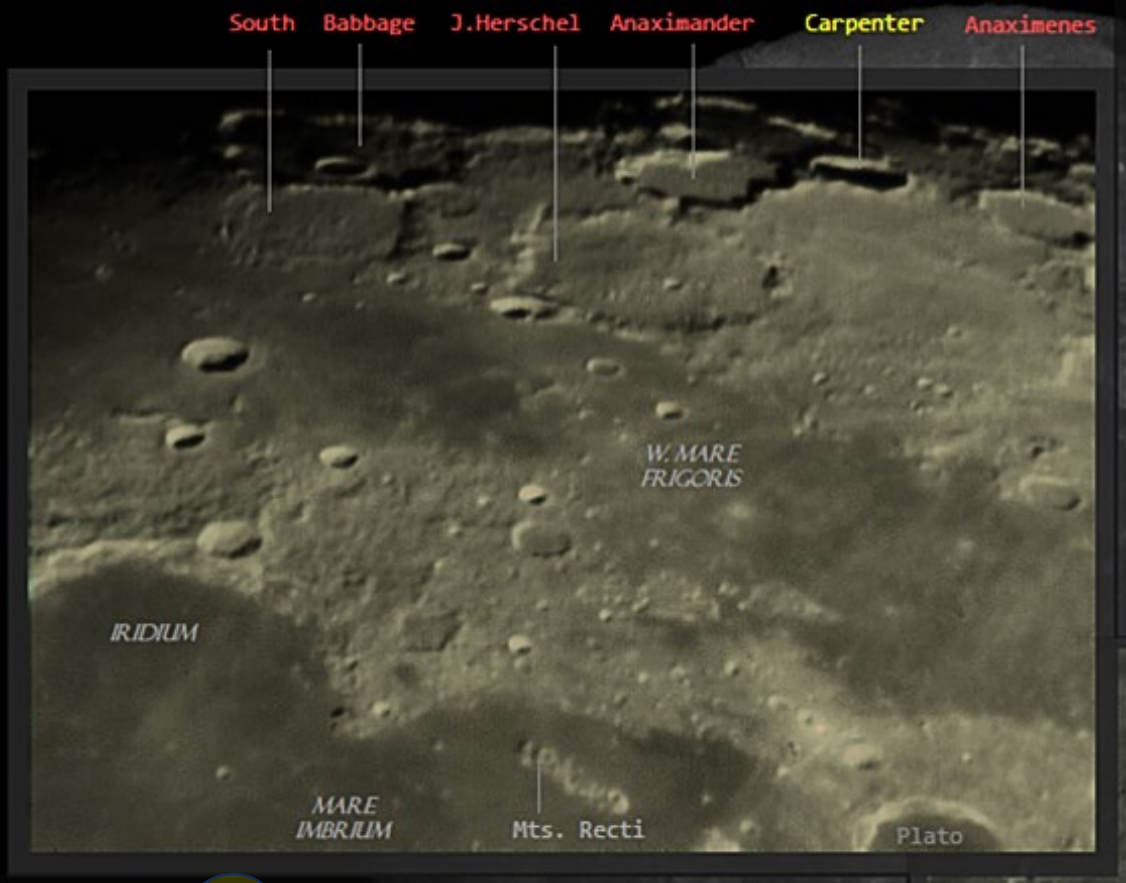
There is much more to study in this area, but I'll need to take pictures with more resolution to go into the details.

12 DAY MOON

Waxing Gibbous MOON,
2020-08-31 00:15 Local CEST (UT+2).
Phase 12 Day, Illum 95%,
Alt 11°, Trsp. 4-5/7 , Seeing 4-5/10

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

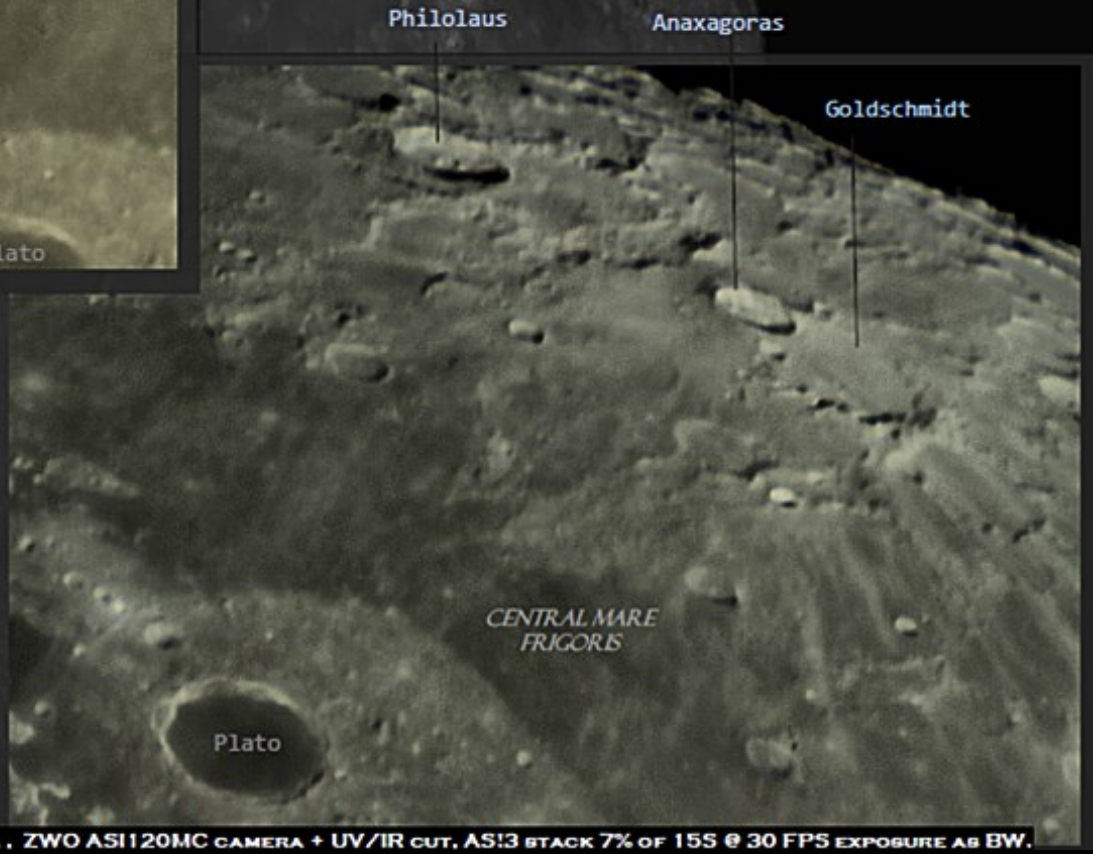

Waxing Gibbous MOON, 2020-08-31 00:15 Local CEST (UT+2). Phase 12 Day, Illum 95%, Alt 11°, Trsp. 4-5/7 , Seeing 4-5/10
1
CENTRAL MARE FRIGORIS
2
WESTERN MARE FRIGORIS
3
ARISTARCHUS - MARIUS
4
SCHICKARD
~88x Mag. in 42 arcmin TFOV, Zeiss 180/1800 Mak, Zeiss 2x Barlow, TV 41mm PAN eyepiece, iPhone XS a-focal snapshot, NightCap app, Exposure 1/300s @ ISO-24



2 WESTERN MARE FRIGORIS

Mare Frigoris resides in a low trough, probably created by the Procellarum impact; Later this excavation was partly covered by ejecta from the Imbrium impact, which also draped the large old pre-Nectarian craters in the highland up towards the north pole (Babbage, J.Herschel, Anaximander, Anaximenes) with a thick carpet of rubble. The West and East part of the trough were finally filled with lava in upper Imbrium, while the central Mare Frigoris was lava covered again later in the Eratosthenian Epoch.

To the left is seen in dramatic profile the degraded shallow ancient craters, largely filled in by Imbrium Basin ejecta.

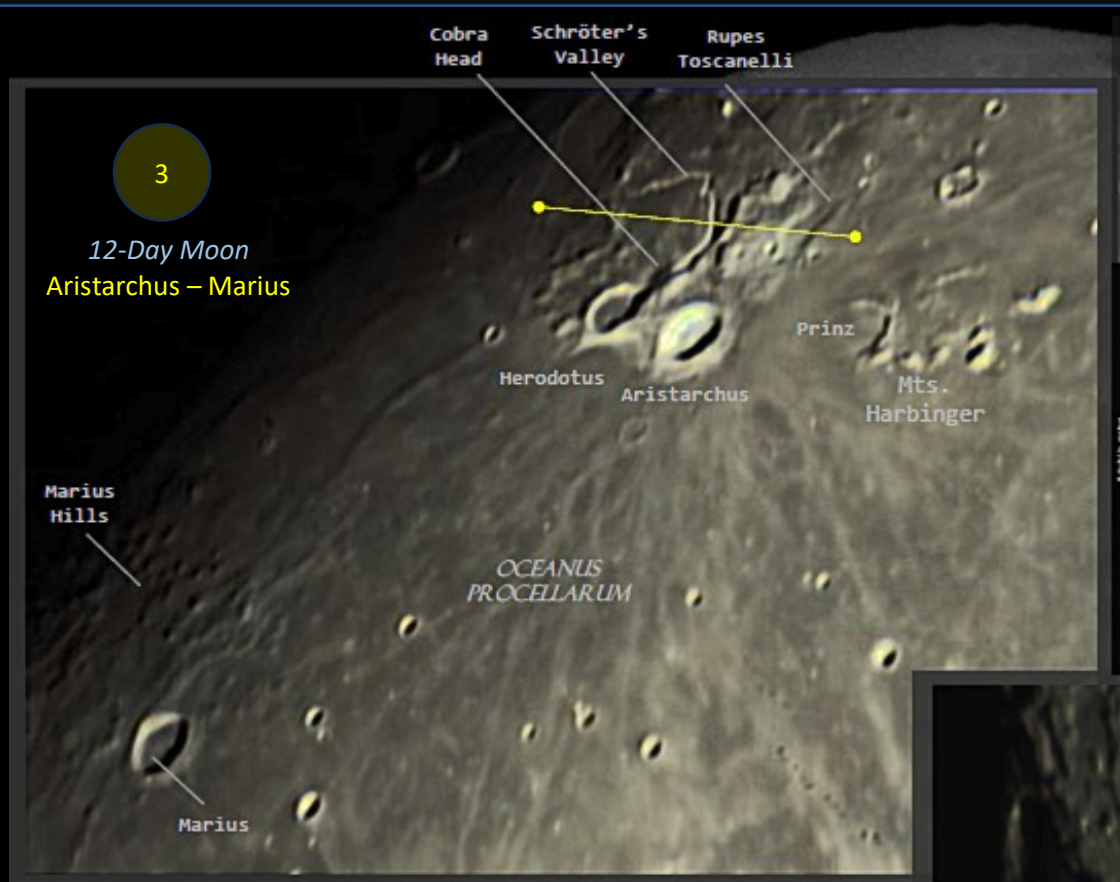


1 CENTRAL MARE FRIGORIS

The central Frigoris area shows some large and degraded pre-Nectarian craters (such as Goldschmidt), but the view is dominated by the young Copernican craters Philolaus and Anaxagoras, -- the first with an unusual pair of clearly separated "twin peaks" while the latter has created a bright web of (relatively) fresh ejecta rays.

A double-peak crater is not that unusual, I think, -- it seems to be caused in a rebound from a somewhat oblique impact, which is also indicated by an uneven distribution of impact melt in such craters.

~140x Mag. In ~ 10 Arcmin TFOV. Zeiss 180/1800 MAK, Zeiss 2x Barlow. , ZWO ASI120MC camera + UV/IR cut. AS!3 stack 7% of 155 @ 30 FPS exposure as BW.



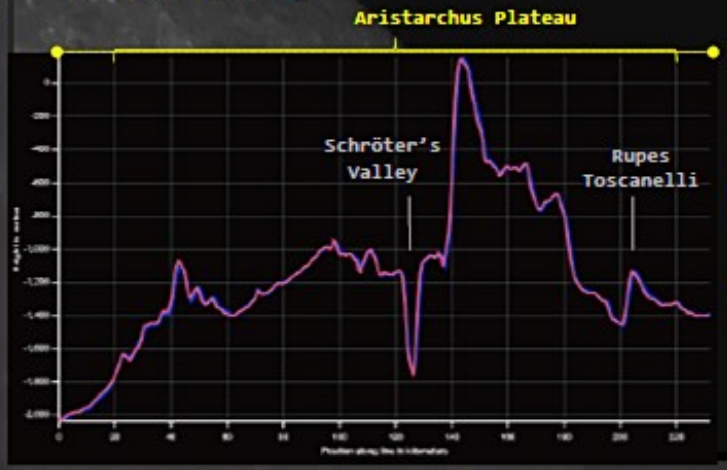
3

12-Day Moon

Aristarchus – Marius

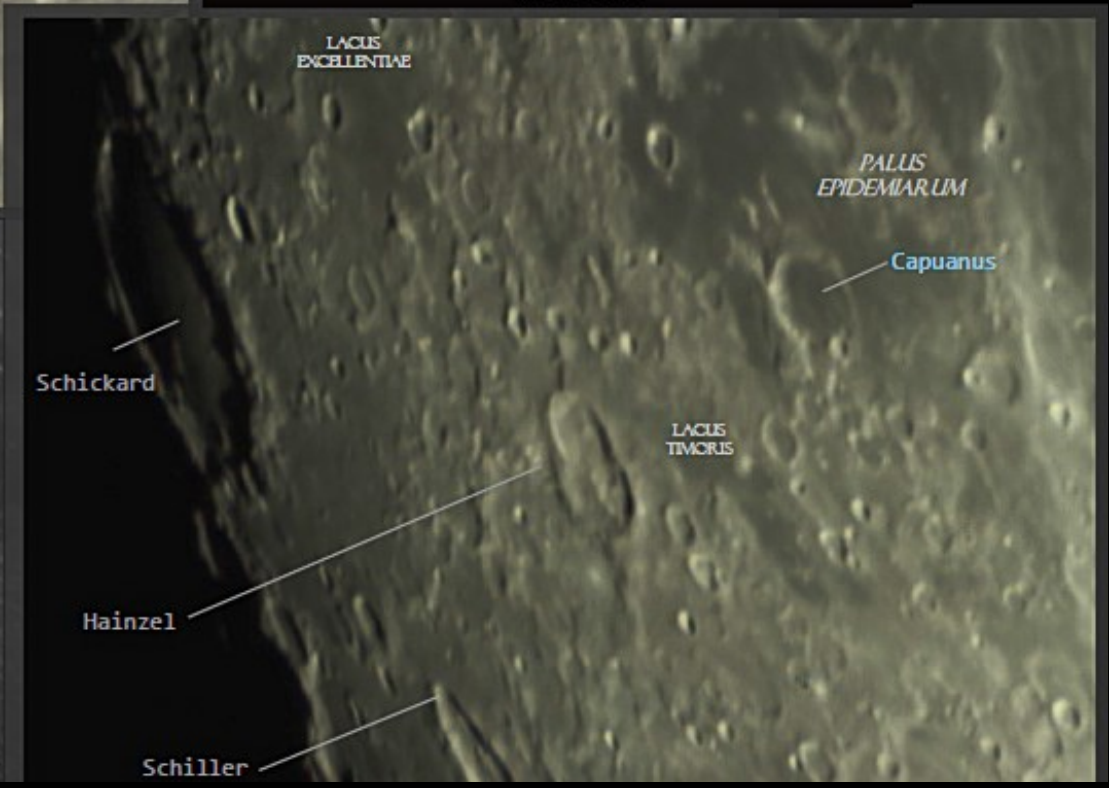
ARISTARCHUS - MARIUS

So, rounding up the "usual suspects" here, in the W part of Oceanus Procellarum... The overall features are visible, albeit a bit soft tonight. Here's a transect across the Aristarchus plateau; The plateau is a ~200Km wide block with a mean height of ca 1 Km above the surroundings.



Schröter's Valley is ca. 800m deep and 8Km wide at the point of this transect .

A monster of a lava channel!



4

SCHICKARD

This sector of the Moon displays a mixture of smooth lava plains peppered with some impressive large craters, notably Schickard, the Hainzel triplet and the unusual elongated Schiller "footprint".

The low-lying areas of *Excellentiae, Timoris and Epidemiarum* may be peripheral depressions left by the ancient Procellarum impact, (like Frigoris), that were later possibly deepened as outer troughs in the creation of the Nubium and Humorum basins, before they were filled in by the Upper Imbrian lava flows.

Aristarchus Plateau Procellarum NW, 12-DY

It's late January 2016, 22h local time. There's a 12-day waxing gibbous (83% illum.) moon hanging high up (ca. 50° alt.) almost due south, on the border between Orion and Gemini. The weather is calm and freezing (-10°C/14°F) with above medium transparency and seeing, and after 20 minutes under the stars my Vixen FL-80S doublet refractor has now fully adapted to the >25°C temperature drop from the warm room inside our house. There's is no wind, and so it doesn't feel too cold to make a drawing, but my breath is condensing and freezing on the eyepiece turret, so I have to breathe gently out the corner of my mouth…

I point my small refractor at the Moon, centering the view at Aristarchus and the surrounding plateau in the NW part of the great Procellarum Basin. This is one of the most geologically diverse areas on the near side of the Moon, with records of lunar history from the ancient pre-Imbrian (>3.8 BY) up to the youngest Copernican epoch (<1 BY).

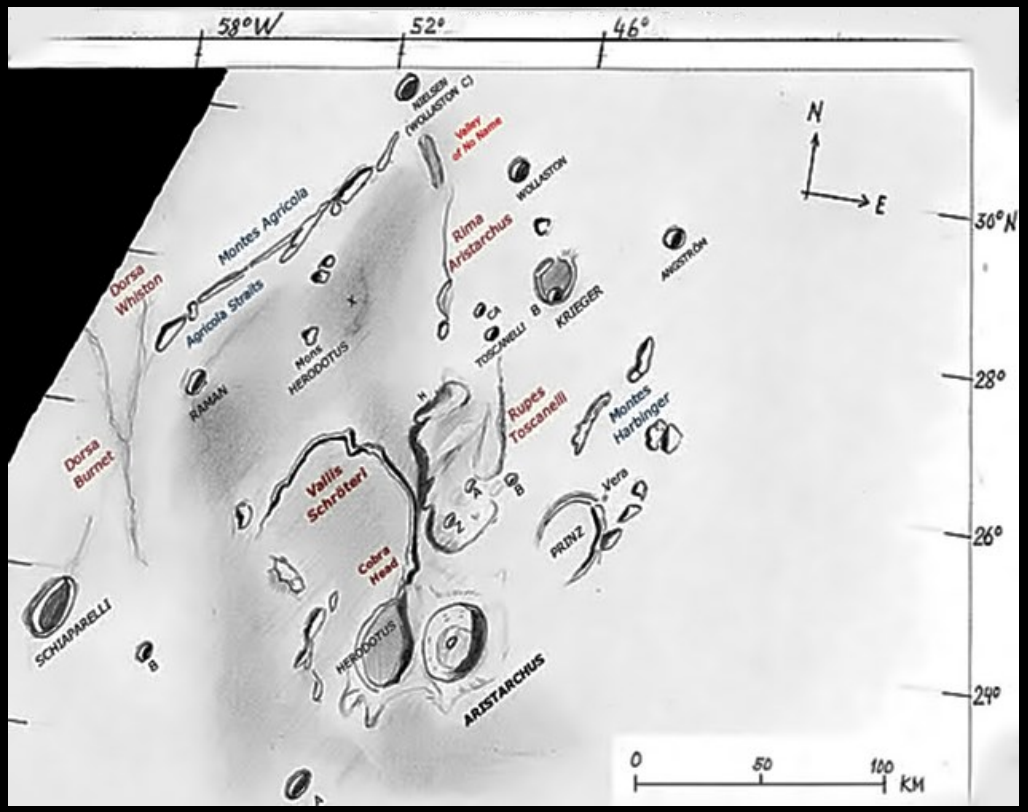
The Imbrium basin impact (3.9 BY) threw up a 4km thick layer of ejecta on top of the surrounding rims and caused a series of linear (radial as well as concentric) tectonic segmentations and faults, including the subsequent 2km uprising of the 170x200 km, diamond-shaped Aristarchus Plateau. The following Orientale basin impact plus the large Herodotus and Prinz craters (all lower Imbrium: ~3.8 BY) further coated the plateau with primary ejecta and secondary craters (thus resetting the crater-age clock of the plateau).

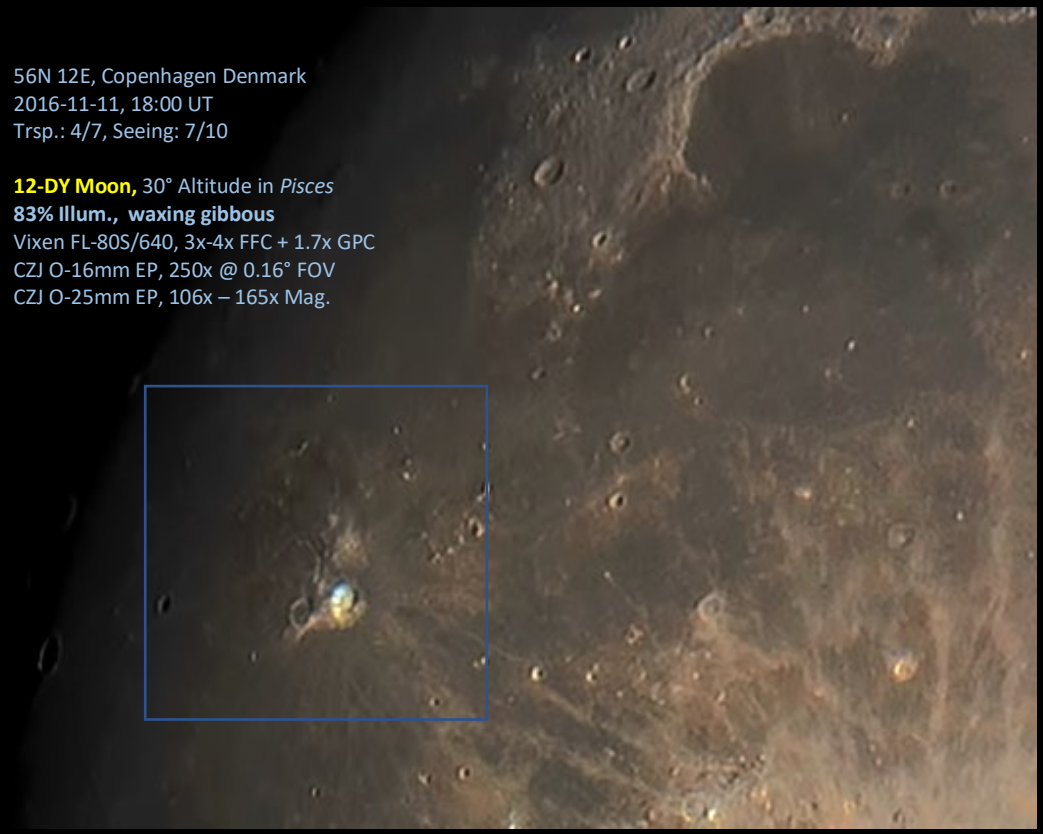
The oldest mare lava extrusions (3.6 BY upper Imbrian red Teleman lava) are found along the extensive faults at the plateau's NW ("Agricola Straits") and E borders; This early flooding was accompanied by pyroclastic volcanic eruptions, that coated the plateau and surroundings with a 10-20m deep, red iron-rich glassy fine-grained ash : Dark Mantle Deposit (DMD).

Later highly fluid lava (2.7 BY old Eratosthenian dark blue 'Sharp' lava) was erupted from many rimless cobra-head vents, from which they eroded narrow channels down-gradient, including the largest sinuous rille on the Moon, Schröter's Valley on the plateau (11 km wide and almost ½ km deep, running downslope 160 km to the NE). The erupted lava flooded the Plateau surroundings, including the floors of the afore mentioned large impact craters (Herodotus and Prinz).

Aristarchus is a very young (175 MY), 42km wide and 3km deep impact crater from the Copernican epoch (<1 BY); It is sharply defined with a well-developed terraced inner wall, very bright with a high reflectivity caused by underlying anorthositic highland rocks, that has been excavated by the deep impact (Aristarchus is easily spotted in in my 8x30 bino).

There are a lot of smaller geologic features visible under favorable conditions, and with larger telescopes: the dark bands in the western crater wall of Aristarchus, the small cobra head vents and rilles in the Montes Harbinger region, the sinuous riles Rimae Aristarchus to the NW of the plateau, the steep mare ridge edge Rupes Toscanelli, the lunar dome Herodotus Omega just S of Herodotus, the Dorsum Niggli running from the Mts. Agricola across the Agricola Straits to the Aristarchus Plateau, the bright ejecta rays from crater Aristarchus, and much more...





56N 12E, Copenhagen Denmark
2016-11-11, 18:00 UT
Trsp.: 4/7, Seeing: 7/10

12-DY Moon, 30° Altitude in *Pisces*
83% Illum., waxing gibbous
Vixen FL-80S/640, 3x-4x FFC + 1.7x GPC
CZJ O-16mm EP, 250x @ 0.16° FOV
CZJ O-25mm EP, 106x – 165x Mag.

I was out on December 16. in the late afternoon at 18:00 local (UT+2), with my 4" refractor to have a look at the **95% illuminated (~12 Day) Moon**; The Moon was up at ~30° Altitude towards the east, just above my rooftop in my suburban backyard, and the transparency was good, -- but the seeing was badly degraded by wind and the N. Atlantic Jetstream winding down above Denmark.

The most conspicuous of the Lunar landscapes in this lunation are the well-lit Great Peninsula **and the** Southern Highlands**,** with the very bright young (~100 Myr) Copernican-era craters residing as spiders in their large "webs" of anorthositic highland crust that has been excavated by the impacts and tossed out in large rays as a mixture of melted and pulverized crust, with embedded larger rocks and boulders forming secondary craters and smaller rays. I've uploaded a full-resolution image from this observation here: https://www.flickr.com/photos/139500911@N04/51753250553/in/album-72157718467405761/

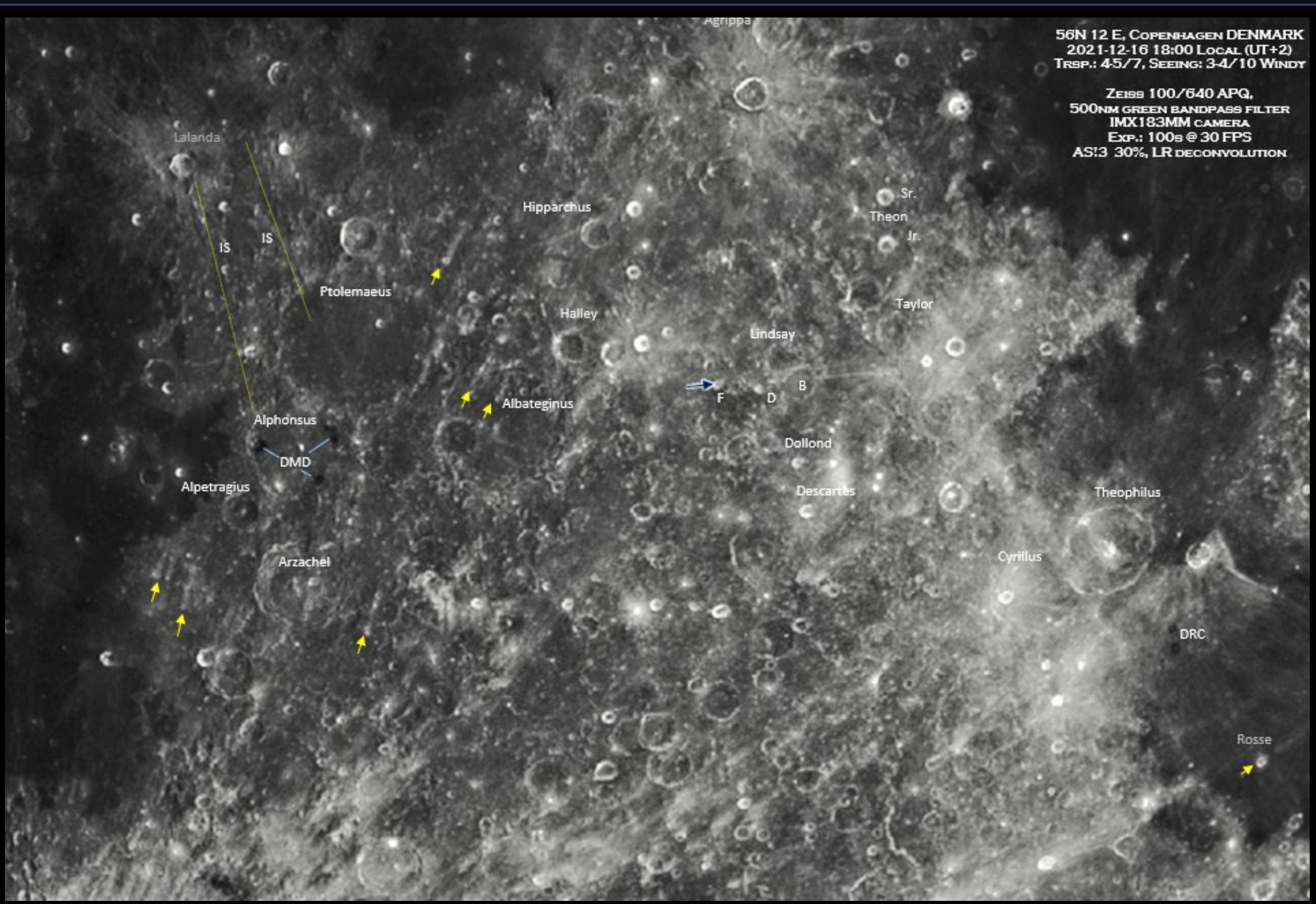
It is often stated that, for instance: "*while Ross lacks a ray system of its own, rays from distant Tycho cross it*." I think this may not be strictly true, as studying the *Rosse* ray, I rather think it may be created as ejecta from a secondary impact by a large boulder flung out from the Tycho crater. As seen here, close to the full Moon, there are many such "tadpole craterlets", each with a ray "tail" radiating away from the Tycho crater, and a natural interpretation would be that these formed when large boulders from the Tycho crater excavation impacted the lunar crust forming secondary craters. I have indicated a few of such proposed Tycho secondary craters and chains on my image below (yellow arrows).

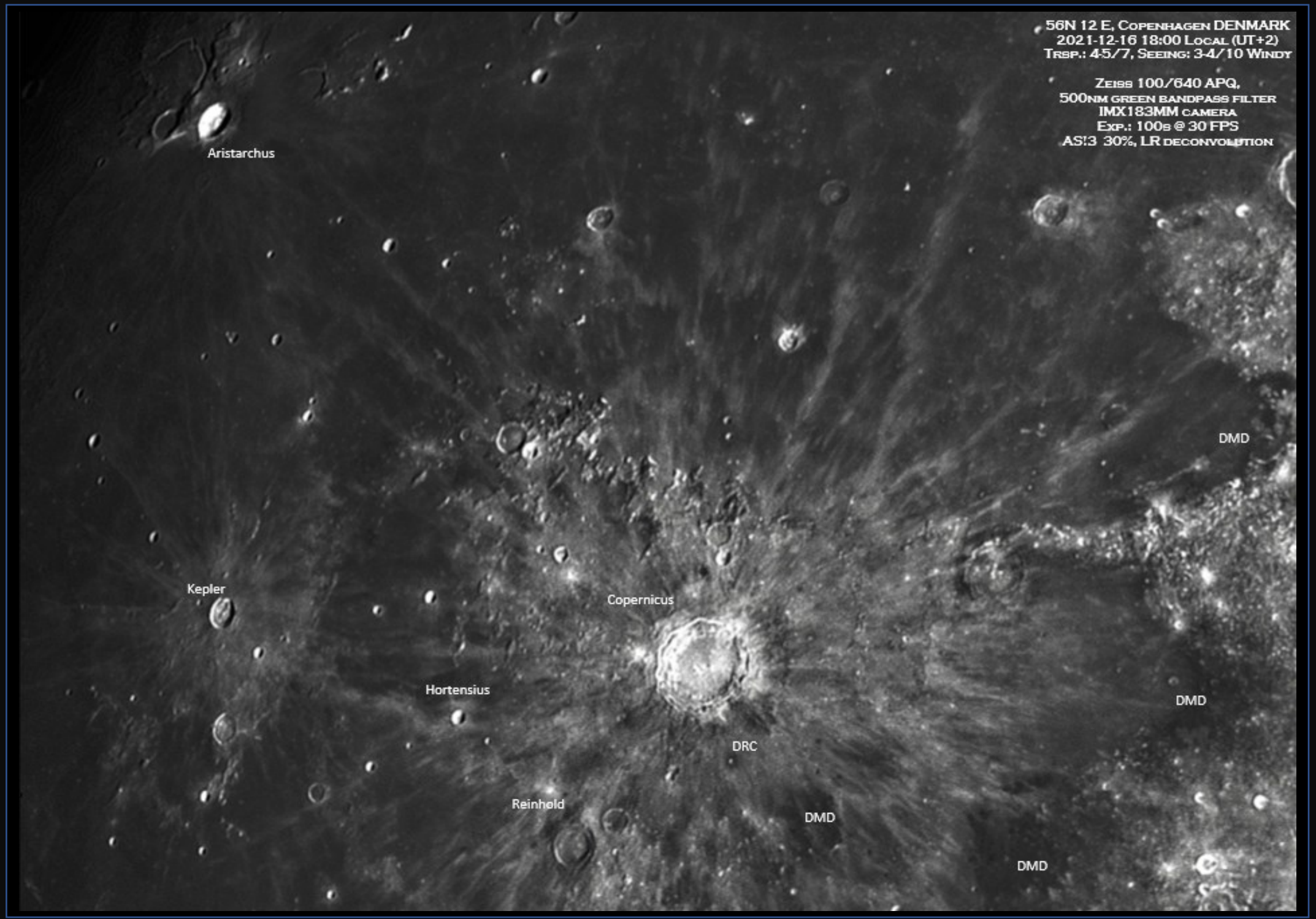
There's a pair of ejecta rays that obviously cut across the radial Tycho rays in a roughly West->East direction; These seem to originate close to the craterlet marked F (blue arrow) on my image (Rükl nomenclature), from where they stretch east across *Lindsay B* crater and the *Caley Plains*, just above the Apollo 16 LM landing site. This indicates a young (Copernican) impact that is not connected to the Tycho crater ejecta. I have not come across any information on this lunar feature...

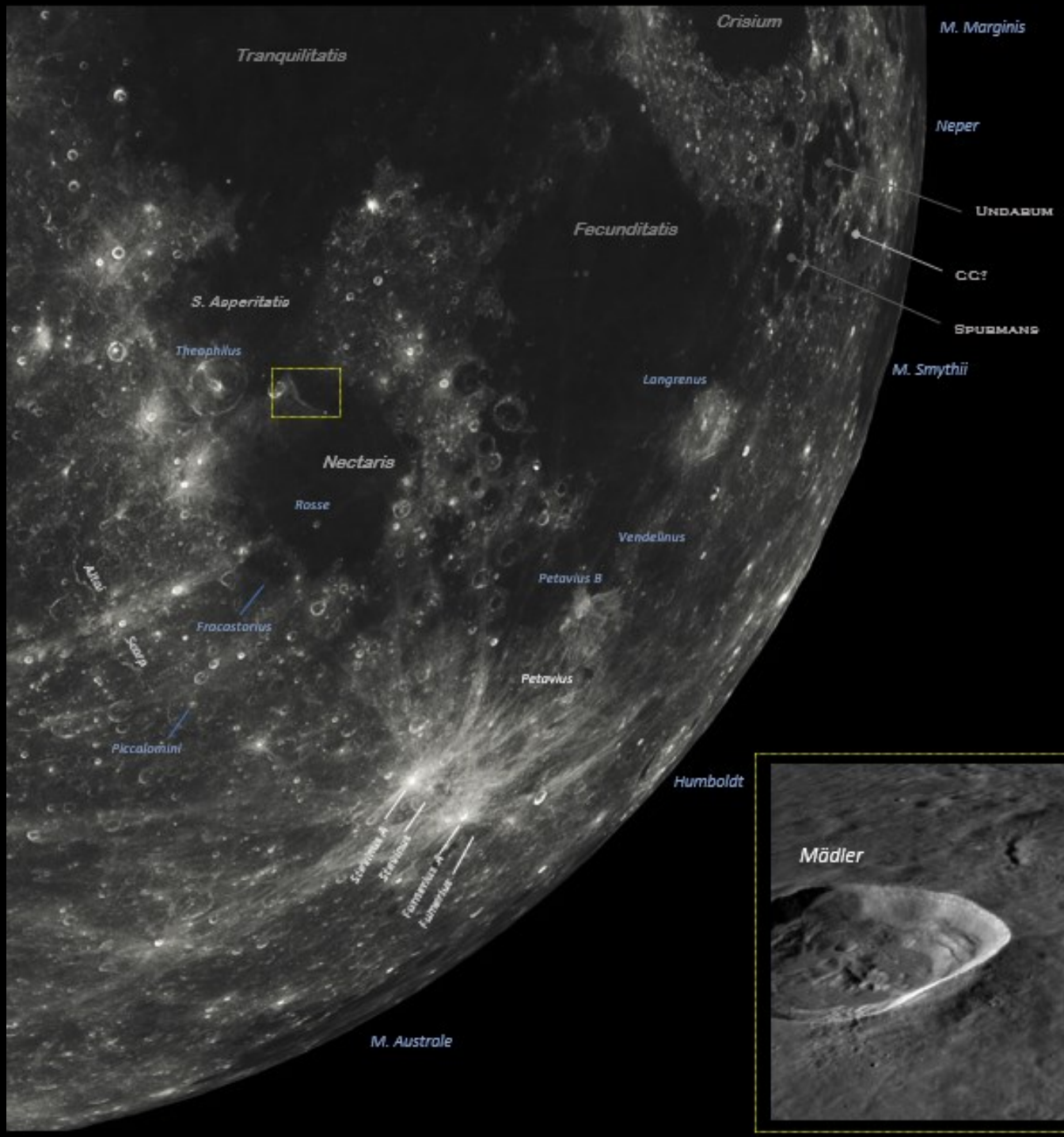
Besides the Copernican crater Ray Systems, there are many other interesting features to be studied in the days close to full Moon: the dark mantle ash deposits (DMD) and dark rimmed craters (DRC) .. I've marked a few -- plus the straight rims and lineaments radial to the Imbrium Basin (the "Imbrium Sculpture", IS) such as the furrows cutting through Ptolemaeus and Alphonsus.

Next to Tycho, the most impressive ray systems on the Lunar near side are those of **Copernicus** and (to a lesser degree) **Kepler**. The far-flung bright ray system of Copernicus extends up to 700 Km across northern Mare Imbrium and down southern Aestuum, Insularum and Procellarum, with many bright small pits in chains and groups indicating secondary impact craters formed by boulders flung out from the Copernicus excavation. The ray web around Kepler seems to be more asymmetric, where the impactor has followed a shallower trajectory from the NW, as indicated by the butterfly pattern thrown out in this direction, plus the main ejecta ray radiating out south of Hortensius down SE towards Reinhold.

12 Day Moon


56N 12 E, Copenhagen DENMARK
2021-12-16 18:00 Local (UT+2)
Trsp.: 4-5/7, Seeing: 3-4/10 Windy
Zeiss 100/640 APQ,
500nm green bandpass filter
IMX183MM camera
Exp.: 100s @ 30 FPS
AS!3 30%, LR deconvolution
Agrippa
Lalande
IS
IS
Ptolemaeus
Hipparchus
Sr.
Theon
Jr.
Taylor
Halley
Lindsay
F
D
B
Albateginus
Alphonsus
DMD
Alpetragius
Dollond
Descartes
Theophilus
Arzachel
Cyrillus
DRC
Rosse


56N 12 E, Copenhagen DENMARK
2021-12-16 18:00 Local (UT+2)
Trsp.: 4-5/7, Seeing: 3-4/10 Windy
Zeiss 100/640 APQ,
500nm green bandpass filter
IMX183MM camera
Exp.: 100s @ 30 FPS
AS!3 30%, LR deconvolution
Aristarchus
Kepler
Copernicus
Hortensius
Reinhold
DRC
DMD
DMD
DMD
DMD
DMD

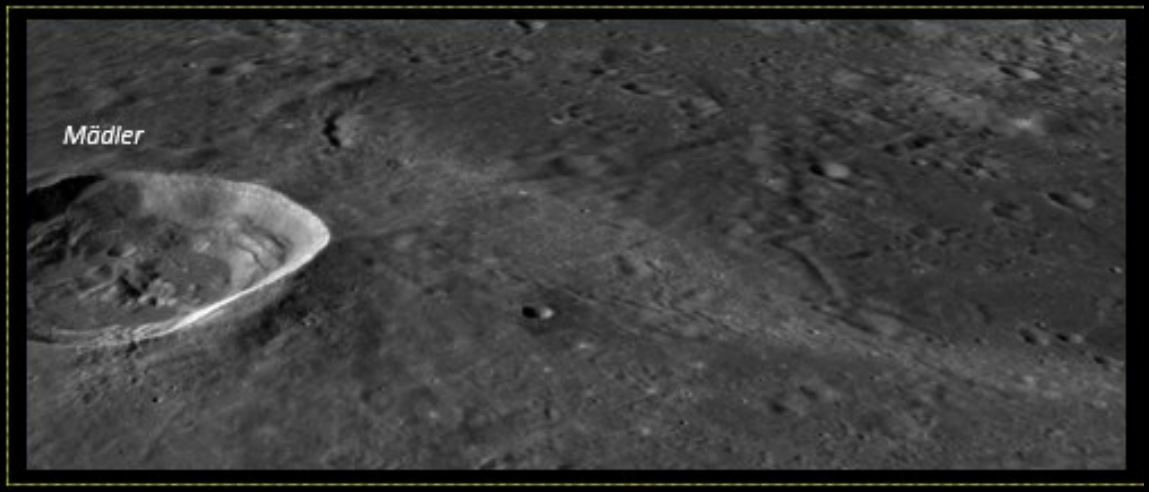


Looking at the **Southern Highlands**, there are a pair of notable Copernican era impacts with very bright ejecta webs located in the lower SE quadrant of the Moon, just above Mare Australe.

The craters themselves **(Stevinius A and Furnerius A)** are anything but impressive, being only ~10Km diameter, but the longest of the **ejecta rays stretch far out**, over a 2000 KM across the lunar surface! Looking at the butterfly ray patterns, it seems like the impacting meteors must have come in by a relatively low trajectory from the SE, throwing out the crazy long ejecta ray past *Fracastorius* and *Theophilus*, then grazing the SW shore of *Sinus Asperitatis*.

A perplexing feature of ray deposit is found just E of the crater **Mädler** (marked on my image by the yellow rectangle). It looks like a broad ray of Tycho ejecta ends abruptly without any obvious explanation, -- but looking at the 3D rendering in LROC:QuickMap, maybe the ground-sweeping wave of semi-fluid ejecta from Tycho was stopped effectively by an elevated, winding lava channel acting as a breakwater and drainpipe?

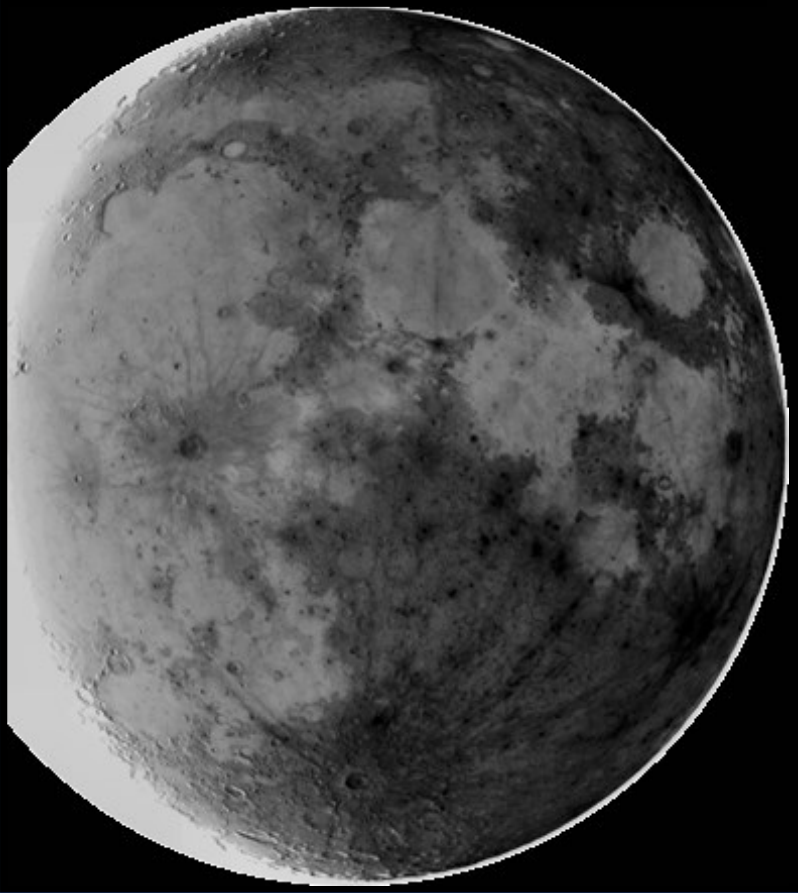
By playing with the contrast (using for instance a polarizing filter) it can be fun to hunt for **old "crypto craters" (CC)** at the -- close to -- full Moon; When looked at in this way, it seems plausible that the maria *Undarum* and *Spurmans* (both south of *Nectaris*) are located each in an ancient, now mostly filled-in and flooded crater, and maybe there's another CC between those two areas? And others...?



12 Day moon
mares and rays

It's November 26. 2020, 1h. past midnight. The temperature is a cool 4dg C, and the humidity is 87% with the dewpoint nearby at 2dgC. The 12-day 90% waxing gibbous moon is hanging low at 17dg altitude in Pisces, surrounded by a weak halo of frosty haze, and the seeing is only so-so medium, so I really ought to be in my bed instead of out in my suburban backyard, -- but it has been overcast the past three weeks, so here I stand, pointing at the moon with my 4" refractor while frost is starting to paint ice flowers on my dew shield.

The almost full moon is a good time to enjoy **the vast seas of mare lava with their crisscrossing rays from lunar impacts**: Tycho and Copernicus of course, but also the smaller butterfly "splashes" from Thales in the NE past Proclus at Crisium and down to Stevinus A - Furnerius A towards the SE. Plus many other interesting bright-spot craterlets and rays, which all show up well if I invert the image:

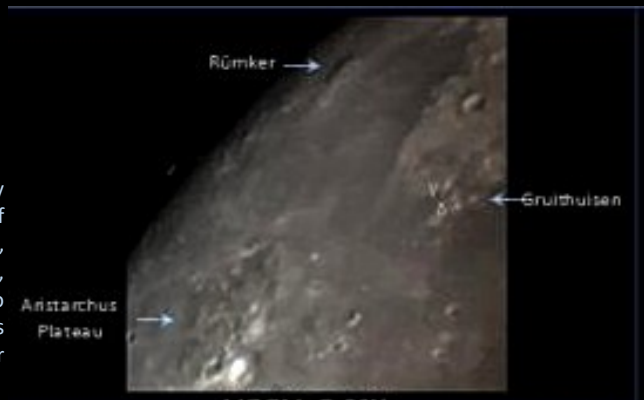


The 12.6-day Moon

It's past midnight this early morning at the end of September (2020-09-30, 01:00 Local DST, CEST UT+2), and I have been out trying to observe the Perseus Molecular Cloud complex (Per MCC);
Though the seeing is good (8/10), the transparency is only ~medium (4/7), and with a high haze in the atmosphere plus an almost full Moon at 27° altitude in Aquarius, the sky is rather "washed out" and not really suitable for DSO.

So, after a short observation of IC348 at the eastern end of the Per MCC, I swing over my 4" refractor towards the Moon to see what is on display up there tonight.

The lunation is close to full Moon (12.6 days), so the "usual suspects" at the terminator towards the W lunar limb are well illuminated: from the Rümker volcanic complex and the Gruithuisen viscous magma domes, past the Aristarchus Plateau nicely dusted with mustard-colored pyroclastic deposits, and down to the Marius Hills region and the Rainer Gamma Swirl.



What's most interesting tonight, however, is that the libration is tilting the NE quadrant towards the Earth, which offers a very good view of the ***Humboldtianum* Basin**. I can in fact see all of Mare Humboldtianum with the Hayn and Bel'kovich craters to the north and the jagged up-tilted Humboldtianum basin rim at the horizon. **The *Marginis* and *Smythii* mares** are also well exposed tonight -- what a wonderful sight! I take a few quick iPhone snapshots through my 13- and 8mm eyepieces, but I'm too tired for a closer up study of Humboldtianum combined with some proper camera shots (-- which I regret today, but as we say in Denmark: "There's always another bus and another girl coming by". And another Moon, of course...)