13-Day
MOON

The Moon, age ~13 days.

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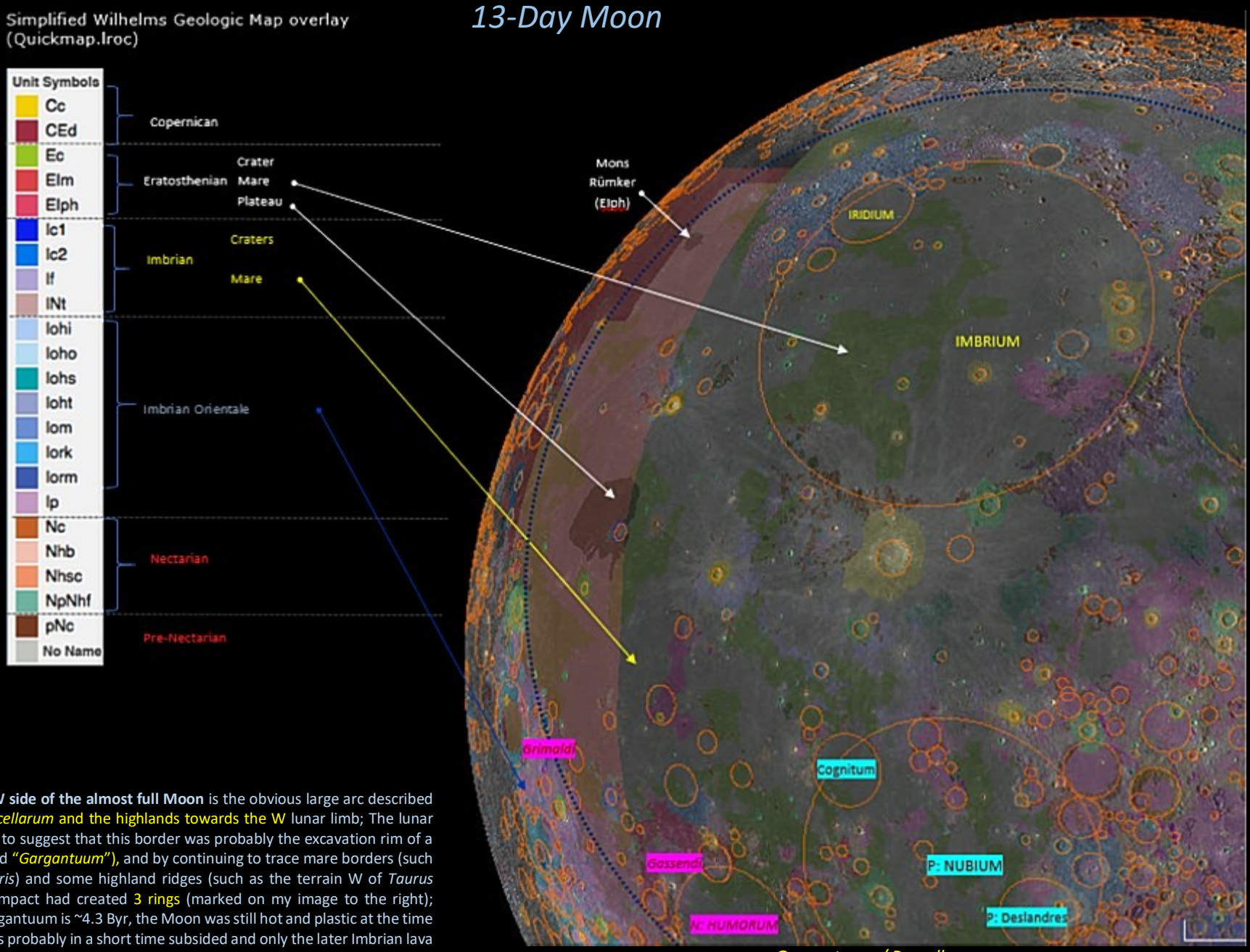
The temperature is mild for the season (5°C) with a relatively high humidity of 81%, and with the dew point close by (at 2°C) the Moon is now centered in a halo of high ice crystals. Overall, the transparency is a horrible 2-3/7 but the seeing is an OK 6-7/10 with minor shimmering of the moon image.

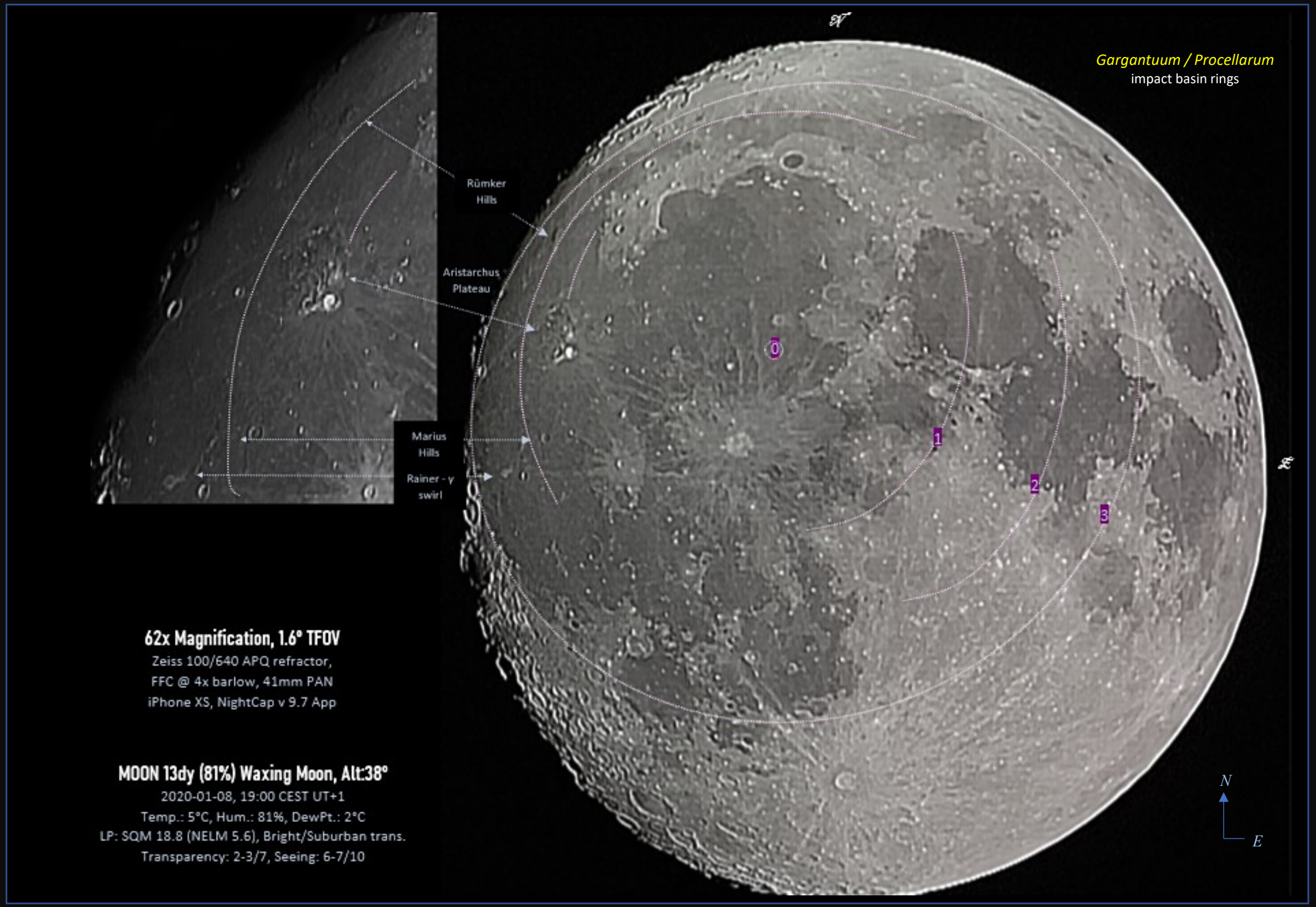
In such circumstances I can always rely on my short f/6.4 four-inch oiled refractor with a well-insulated lens cell, as it is always ready to go within the 10 minutes it takes me to setup the gear, and from here it just gently slides down the temp. diff. slope (Δ 15°C tonight) to ambient, without degrading the excellent view quality .



The most striking feature on the **W side of the almost full Moon** is the obvious large arc described by the border between *Oceanus Procellarum* and the highlands towards the W lunar limb; The lunar scientist *Ewen Whitaker* was the first to suggest that this border was probably the excavation rim of a large pre-Nectarian basin (later named "*Gargantuum*"), and by continuing to trace mare borders (such as the arcuate trough of *Mare Frigoris*) and some highland ridges (such as the terrain W of *Taurus Mountains*), he suggested that the impact had created 3 rings (marked on my image to the right); However, as the estimated age of Gargantuum is ~4.3 Byr, the Moon was still hot and plastic at the time of impact, so -- as expected -- the rings probably in a short time subsided and only the later Imbrian lava fill of the basin plus a few arcuate highland ridges now remain for us to "connect the dots".

Gargantuum / Procellarum

For completeness, here's an outline of the Gargantuum basin with the main geological landforms (mare plains and largest craters) that has later filled in the excavation (Wilhelms Geological Map, as pr. 2013 renovation. *LROC Quickmap*).

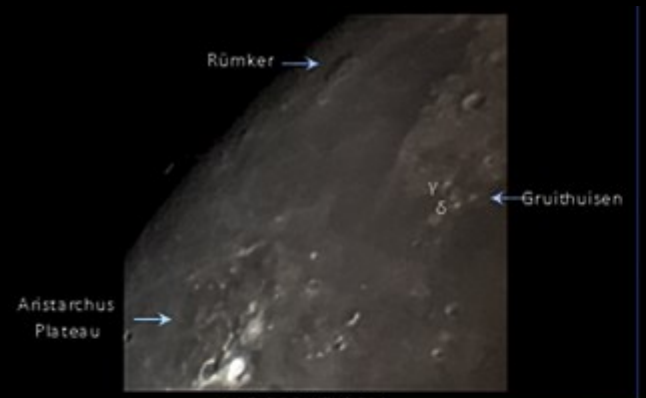

Gargantuum / Procellarum
impact basin rings
Rümker
Hills
Aristarchus
Plateau
Marius
Hills
Rainer - γ
swirl
0
1
2
3
62x Magnification, 1.6° TFOV
Zeiss 100/640 APQ refractor,
FFC @ 4x barlow, 41mm PAN
iPhone XS, NightCap v 9.7 App
MOON 13dy (81%) Waxing Moon, Alt:38°
2020-01-08, 19:00 CEST UT+1
Temp.: 5°C, Hum.: 81%, DewPt.: 2°C
LP: SQM 18.8 (NELM 5.6), Bright/Suburban trans.
Transparency: 2-3/7, Seeing: 6-7/10
N
E

13 Day Moon

2020-09-30

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*** dusted by 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 (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...)

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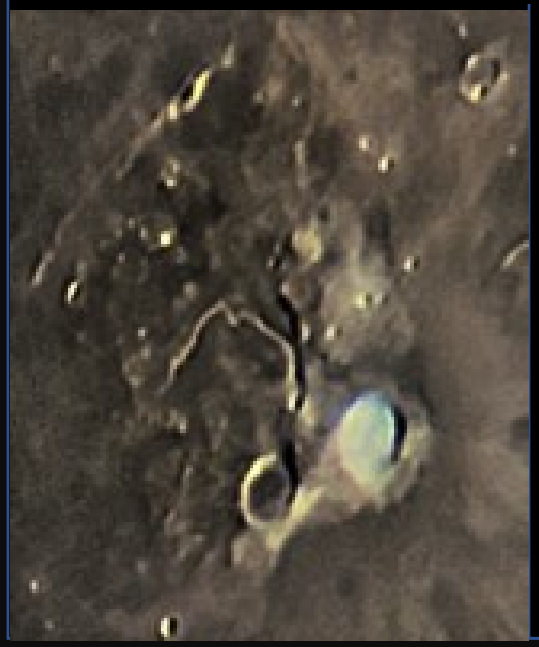
The most striking feature on the W side of the almost full Moon is the obvious large arc described by the border between Oceanus Procellarum and the highlands towards the W lunar limb; The lunar scientist Ewen Whitaker was the first to suggest that this border was probably the excavation rim of a large pre-Nectarian basin (later named "**Gargantuum**"), and by continuing to trace mare borders (such as the arcuate trough of Mare Frigoris) and some highland ridges (such as the terrain W of the *Taurus Mountains*) he suggested that the impact had created 3 rings; However, as the estimated age of Gargantuum is ~4.3 Byr, the Moon was still hot and plastic at the time of impact, so as expected, the rings probably in a short time subsided and only the later Imbrian lava fill of the basin plus a few arcuate highland ridges now remain for us to "connect the dots".

All along the NW rim of the Gargantuan Basin are traces of volcanic activity: from the ***Rümker Hill*** coalescing domes with a large caldera towards the E, past the uplifted block of the ***Aristarchus Plateau*** with lava covering from Schröter's Valley and DMD mantling from the Cobra Head vent, to the ancient magma hot-spot ***Marius Hills*** that now features several hundred small volcanic cones. This extraordinary concentration of volcanic complexes was probably caused by the Imbrium impact into the already thin crust excavated by the pre-Nectarian Gargantuum excavation.



Here's a raw image of the Moon: 13 days, 95% illumination ,143x magnification, 0.28dg FOV : Date: May 1, 2015, Time: 19:30, Seeing: 3/5, Transparency: 7/10

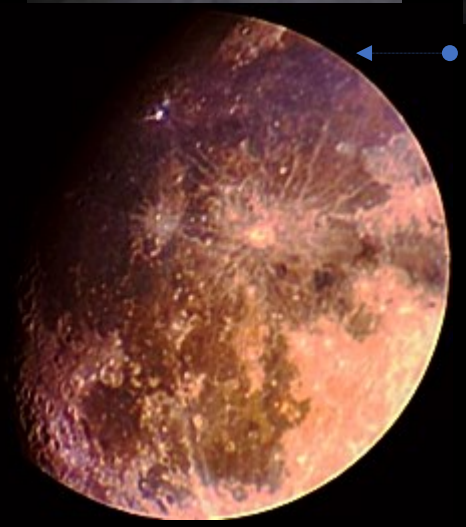
Telescope: Carl Zeiss Jena AS63/840 Telementor (semi-apo refractor),
Mount : Carl Zeiss Jena Parallactic TM on 2V tripod
Accessories : focal extender: Baader 1.7x GPC, Focal length: 1430,
Eyepiece: CZJ 10-O orthoscopic;
Camera: Apple iPhone 4 1/3.2" BSI CMOS (8MP, 1.4um),

Hand held at the eyepiece (1 frame, no stacking or postprocessing; Surely not the best focus nor resolution -- but still useful :)

The raw image from the iPhone-4 camera shows (among other objects) :

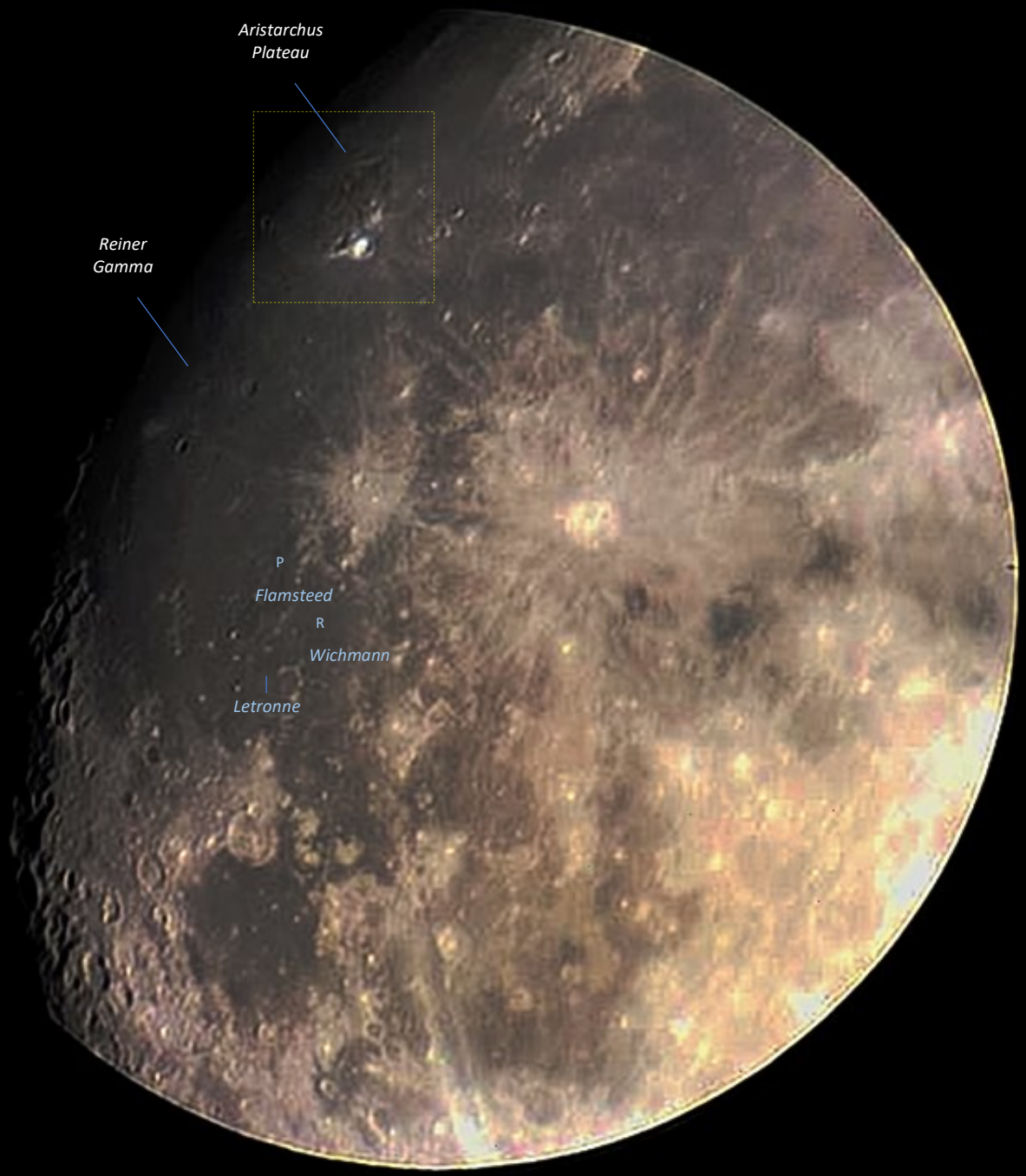
- the *Reiner Gamma* swirl (local magcon) and
- the flooded craters in S. Procellarum (*Flamsted P, Wichmann R, Letronne*);

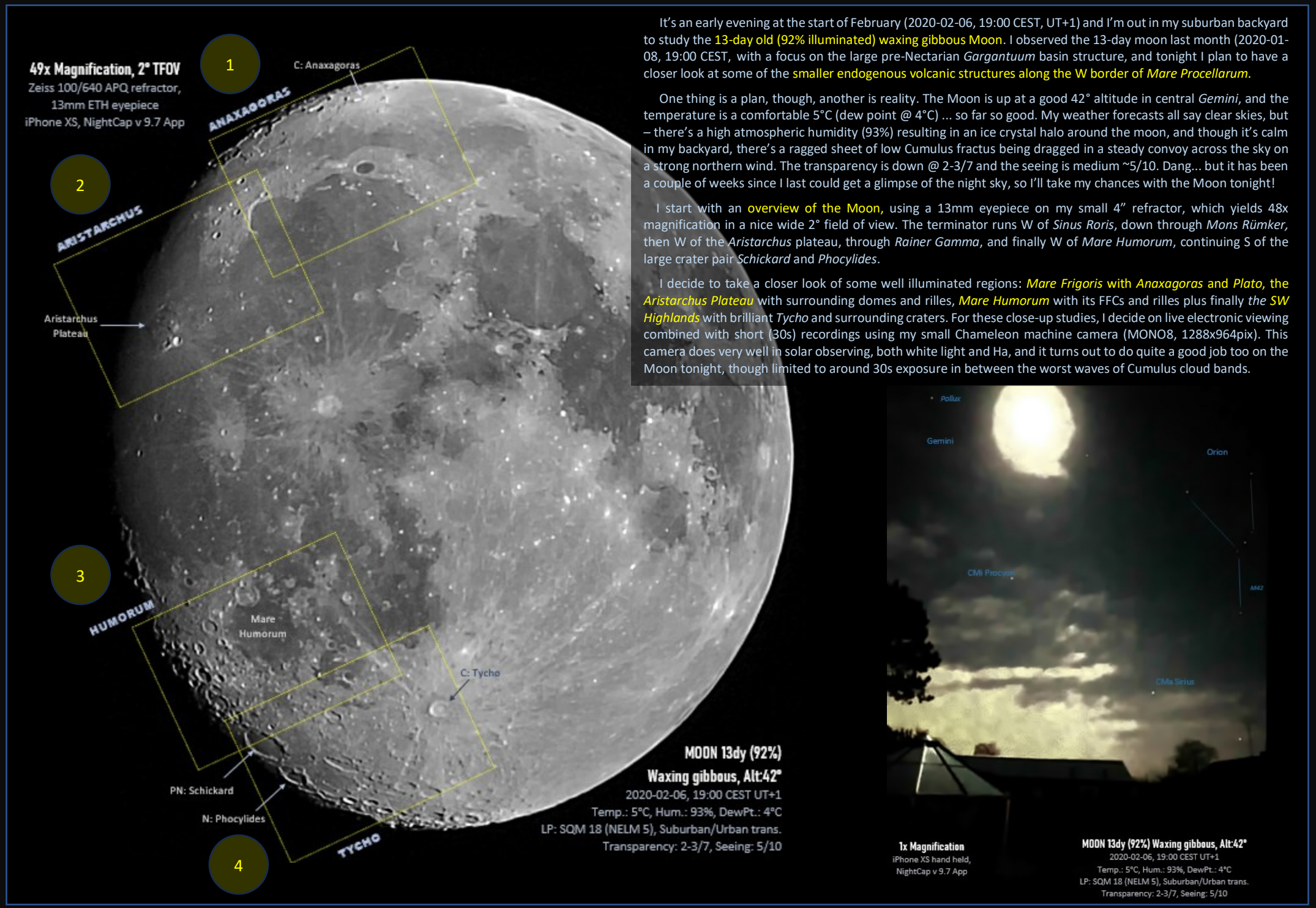
-- What caught my eye though, was the distinctively darker, reddish hue of the 2 km elevated *Aristarchus plateau*, which has been linked to the volcanic origin of the *Schröter Valley / Cobra head* formation (Vulcanic ash with iron/sulfur deposits). :



To the left, I have adjusted the saturation of the iPhone color image; The lunar maria show a mostly uniform, greyish color to the naked eye, the noticeable exception being the dark grey areas known as DMDs (Dark Mantle Deposits: pyroclastic crystalline / glass bead soils), which are clearly seen in even the raw/unprocessed photo.

In the color saturation "enhanced" version, the north Imbrium and Procellarum show a faint bluish hue, while the Nubium and surrounding areas show a warmer, more red hue. My guess is, that this difference in albedo is reflective (so to speak) of the north Imbrium/Procellarum basalts having a higher TiO2 – Fe content than the Nubium ditto.





It's an early evening at the start of February (2020-02-06, 19:00 CEST, UT+1) and I'm out in my suburban backyard to study the 13-day old (92% illuminated) waxing gibbous Moon. I observed the 13-day moon last month (2020-01-08, 19:00 CEST, with a focus on the large pre-Nectarian *Gargantuum* basin structure, and tonight I plan to have a closer look at some of the smaller endogenous volcanic structures along the W border of *Mare Procellarum.*

One thing is a plan, though, another is reality. The Moon is up at a good 42° altitude in central *Gemini*, and the temperature is a comfortable 5°C (dew point @ 4°C) ... so far so good. My weather forecasts all say clear skies, but – there's a high atmospheric humidity (93%) resulting in an ice crystal halo around the moon, and though it's calm in my backyard, there's a ragged sheet of low Cumulus fractus being dragged in a steady convoy across the sky on a strong northern wind. The transparency is down @ 2-3/7 and the seeing is medium ~5/10. Dang... but it has been a couple of weeks since I last could get a glimpse of the night sky, so I'll take my chances with the Moon tonight!

I start with an overview of the Moon, using a 13mm eyepiece on my small 4" refractor, which yields 48x magnification in a nice wide 2° field of view. The terminator runs W of *Sinus Roris*, down through *Mons Rümker,* then W of the *Aristarchus* plateau, through *Rainer Gamma*, and finally W of *Mare Humorum*, continuing S of the large crater pair *Schickard* and *Phocylides*.

I decide to take a closer look of some well illuminated regions: *Mare Frigoris* with *Anaxagoras* and *Plato*, the *Aristarchus Plateau* with surrounding domes and rilles, *Mare Humorum* with its FFCs and rilles plus finally *the SW Highlands* with brilliant *Tycho* and surrounding craters. For these close-up studies, I decide on live electronic viewing combined with short (30s) recordings using my small Chameleon machine camera (MONO8, 1288x964pix). This camera does very well in solar observing, both white light and Ha, and it turns out to do quite a good job too on the Moon tonight, though limited to around 30s exposure in between the worst waves of Cumulus cloud bands.

1 *13-Day Moon close-up Plato-Anaxagoras*

I start my close-up observation of the 13-day waxing gibbous Moon from the north, with a study of the NE Imbrium-Frigoris region. I first swap out the 13mm eyepiece for my small CM3 machine-cam, yielding ~200x magnification in a ~0.15° (aka 9") FOV. The live electronic view is quite good, -- in general somewhat shimmering from the mediocre seeing and with some cloud shadows gliding by, but also with moments of sharp details coming through, showing a fine 3D view of the *Philolaus – Anaxagoras* area towards the terminator. Here's a short recording of the live view: https://youtu.be/gsb72acjxWc.

The 30s stacked image below shows many interesting details in this area: dominating the view is the bright rays of impact melt and crust debris thrown out of the Copernican age ***Anaxagoras*** crater. The ejecta carpet from this crater is obviously most prominent towards the E, completely covering the old adjacent ***Goldschmidt*** crater, and this asymmetry strongly suggest an oblique impact by a rock coming in low from the W.

The young Copernican craters ***Philolaus and Harpalus*** both show nice details in the terraced walls and central peaks, and besides *Goldschmidt*, other old and wrecked pre-Nectarian large craters also show up well in the 92% illumination: ***Barrow, Meton, W. Bond, Birmingham, Anaximenes, J. Herschel, Babbage, South***... -- and several others, which however are so eroded now, that they have not been honored with a name by IAU.

Plato shows up well with its terraced wall and landslides, and I can also *just* spot the 4 larger craterlets (D-C-A-B, around 2½ km Ø) plus the 2 small (g-h, around 1½ km Ø) impact pits on the central crater floor. I can see the 3 Plato rilles (Rimae Plato I-II-II), where I and III seem to have a "cobra head"-like vent at the start of the rille nearest the Plato crater wall, whereas III has a series of crater vents at the bottom of the rille (like the W Hyginus rille segment). As "Schröter's Valley" on the Aristarchus Plateau, the Plato Rimae are sinuous rilles cut by meandering lava flows. Try as I may, I cannot with certainty spot the central rille (a collapsed lava tube) in ***Vallis Alpes***; With a width of only 0.5-1 km, it seems below the resolving power of my 4" scope at this mediocre seeing.

Using LROC-Quickmap I did **a transect** from Mare Imbrium past the basin rings up NE across the Anaxagoras crater. The profile shows well the low level of the Maria (Imbrium, Frigoris: -2.7 Km), the Imbrium basin rings #1 (Wrinkle Ridge) and #2 (Excavation Rim) plus the Procellarum Basin Rim N of Frigoris, and finally the old Northern Highland crust (height ~ -1 Km) with the Anaxagoras crater as a deep hole down to the level of the Maria.

2 *13-Day Moon close-up Aristarchus*

I continue my close-up observation of the 13-day waxing gibbous Moon, panning south now to the **NW Imbrium** region, while still live viewing with my small CM3 *Chameleon* @ 200x mag. in a 9" FOV.

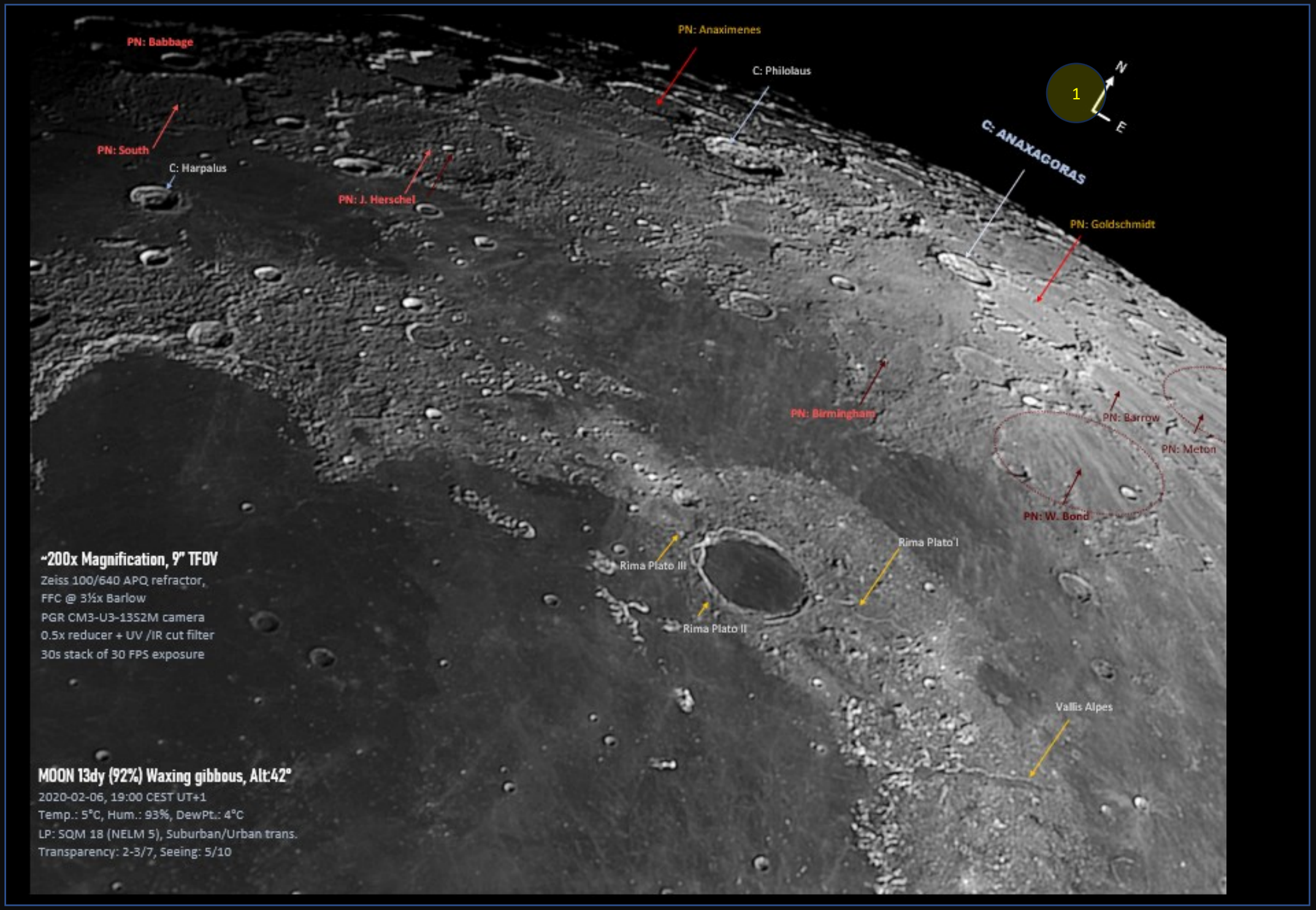
I'm here at the **W edge of the Gargantuum basin** that has filled with relatively young lavas: the westernmost upper Imbrian (3.32 Byr) *Herman* lava, which has been partially covered towards the east by the later Eratosthenian (2.7 Byr) *Sharp* lava. I can see the **Sharp lava channel** (*Rima Sharp*) up towards the NE in Sinus Roris and also the **major Herman lava channels** (*Vallis Schröteri & Rima Marius*) meandering out of the Aristarchus Plateau and the Marius Hills. The western flows of the mare lava fills are clearly indicated by the many N-S oriented Wrinkle Ridges (dorsae), which are beautifully seen in the image below.

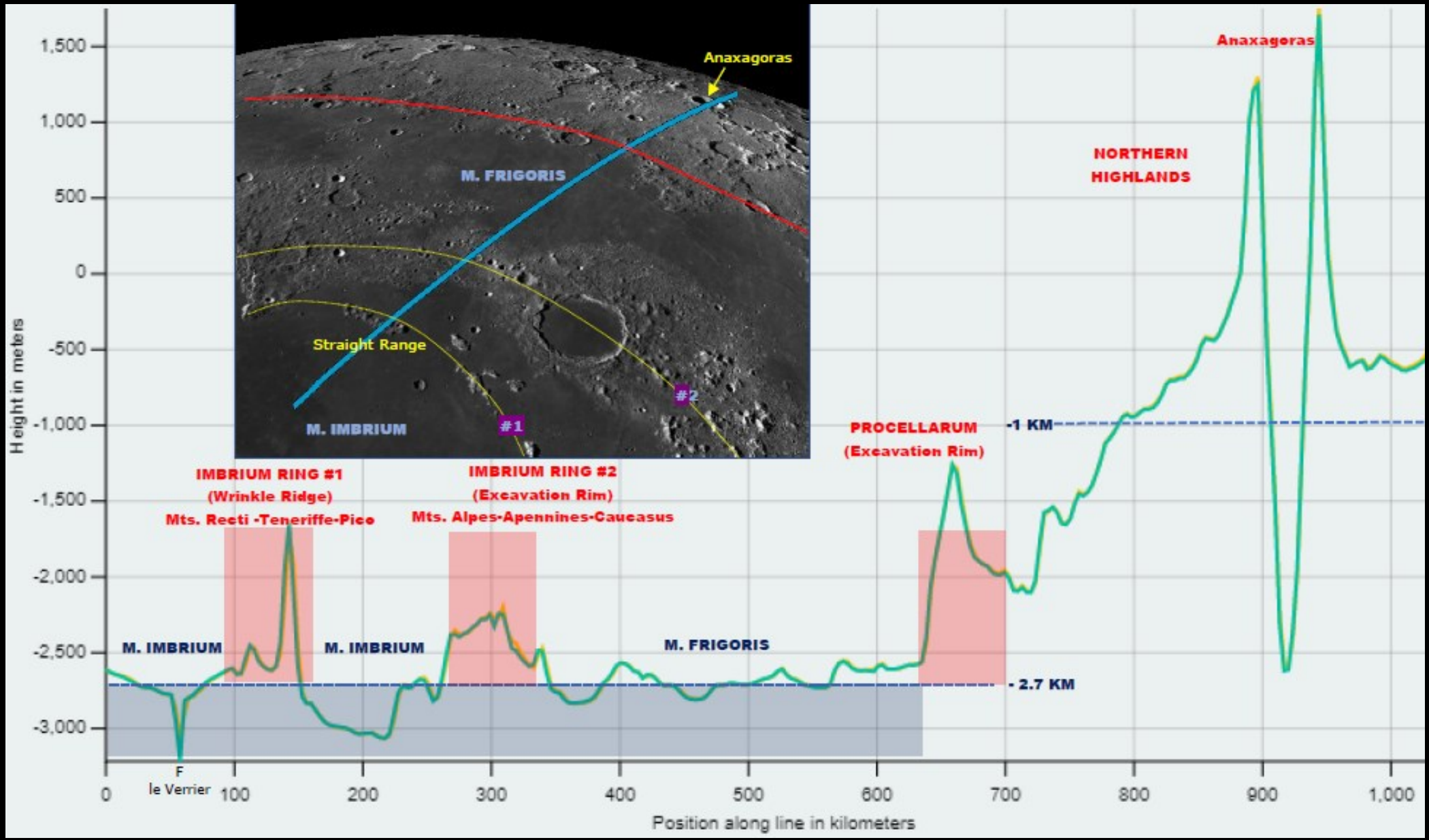
There are several volcanic complexes in this NW part of *Procellarum*, probably caused by major rim fractures in the *Gargantuum* basin, which have acted as conduits for hot magma to penetrate from the mantle to the surface. Here first an overview of the major volcanic features at the W rim of the Gargantuum Basin (the W shore of Oceanus Procellarum:

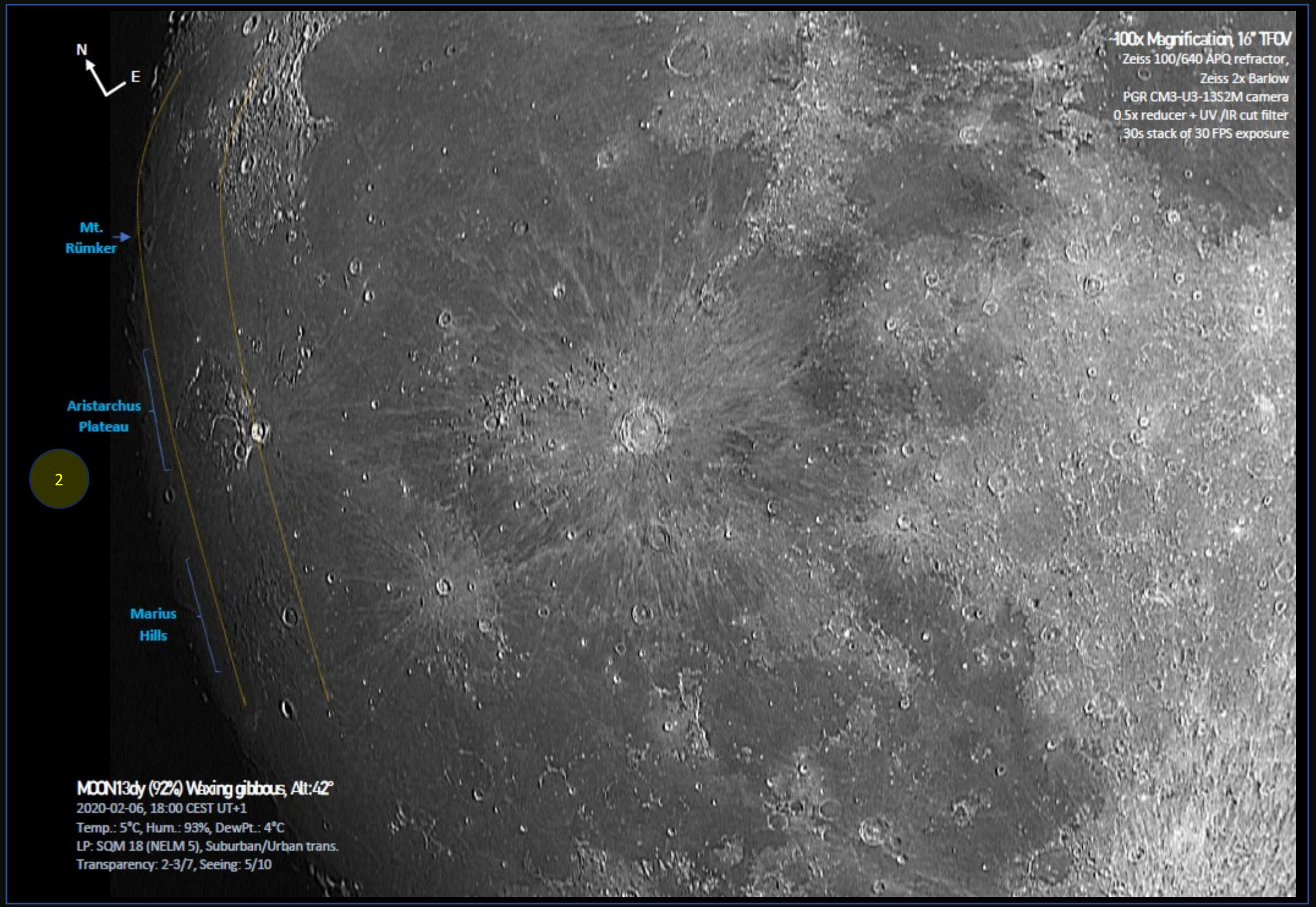
The ***Rümker Hills*** is a large volcanic mound consisting of around a dozen overlapping small domes with many volcanic vents, and with a depression towards the E, which may be a volcanic collapse crater (aka a caldera). East of the Rümker Hills, towards the *Mairan* crater, are seen four isolated volcanic cone-shaped domes formed by low-flowrate, viscous silicic lava. The most conspicuous of these domes is **Mairan T** (marked on my image), surrounded by a NW, Middle and S dome. I couldn't resolve the volcanic vent at the top of *Marian T* tonight. Other examples of early silicic volcanism predating the surrounding lunar mare are seen N of the Eratosthenian crater **Gruithuisen** in the shape of two rounded **domes (γ and δ);** There's a pair of volcanic vents at the top of the γ Gruithuisen dome, -- which I can *just* see hints at in moments of good seeing (?).

The ***Aristarchus Plateau*** is a 2 Km high, 170x200 Km rectangular block of elevated lunar crust, uplifted by magma along fracture lines that were probably created by the Imbrium impact 3.85 Byr ago. The Plateau is covered by deep pyroclastic deposits that were spewed out in large fire fountains from volcanic vents such as the *Cobra Head*. The pyroclastic fireworks were accompanied by fast rivers of lava which created many sinuous channels/rilles on the Plateau itself (*Vallis Schröteri, Rimae Toscanelli*) as well as in the immediate environment such as *Rimae Prinz* with the Vera vent (which I can see) and *Rimae Aristarchus* (which I can't spot tonight). It is evident that the E side of the Plateau is lighter in color/albedo and has a higher crater rate (thus older surface), whereas the W side with Vallis Schröteri forms a smoother, hummocky plain with younger dark ash and iron-rich glass grain mantling (DMD).

The third major volcanic complex in this area (besides *Rümker* and *Aristarchus*) is the **Marius Hills** region, which is only partly visible in the SW corner of my image below. The region features ~300 small cone and dome shaped volcanoes, all coated by pyroclastic deposits (DMD) and located on top of a slight crust uplifting caused by the pressure of underlying unerupted magma. A pair of long sinuous rilles are seen emerging from the region, the longest of which (*Rima Marius*, 275 Km) can be glimpsed meandering up NW on the image.


PN: Babbage
PN: Anaximenes
C: Philolaus
PN: South
C: Harpalus
PN: J. Herschel
C: ANAXAGORAS
PN: Goldschmidt
PN: Birmingham
PN: Barrow
PN: Meton
PN: W. Bond
Rima Plato I
Rima Plato III
Rima Plato II
Vallis Alpes
1
N
E
~200x Magnification, 9" TFOV
Zeiss 100/640 APQ refractor,
FFC @ 3½x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure
MOON 13dy (92%) Waxing gibbous, Alt:42°
2020-02-06, 19:00 CEST UT+1
Temp.: 5°C, Hum.: 93%, DewPt.: 4°C
LP: SQM 18 (NELM 5), Suburban/Urban trans.
Transparency: 2-3/7, Seeing: 5/10


Anaxagoras
M. FRIGORIS
Straight Range
M. IMBRIUM
#1
#2
Anaxagoras
NORTHERN
HIGHLANDS
PROCELLARUM
(Excavation Rim)
-1 KM
IMBRIUM RING #1
(Wrinkle Ridge)
Mts. Recti -Teneriffe-Pico
IMBRIUM RING #2
(Excavation Rim)
Mts. Alpes-Apennines-Caucasus
M. IMBRIUM
M. IMBRIUM
M. FRIGORIS
- 2.7 KM
F
le Verrier
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
-2,500
-3,000
Height in meters
0
100
200
300
400
500
600
700
800
900
1,000
Position along line in kilometers


N
E
Mt.
Rümker
Aristarchus
Plateau
2
Marius
Hills
100x Magnification, 16" TFOV
Zeiss 100/640 APQ refractor,
Zeiss 2x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure
MOON 13dy (92%) Waxing gibbous, Alt:42°
2020-02-06, 18:00 CEST UT+1
Temp.: 5°C, Hum.: 93%, DewPt.: 4°C
LP: SQM 18 (NELM 5), Suburban/Urban trans.
Transparency: 2-3/7, Seeing: 5/10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Temp.: 5°C, Hum.: 93%, DewPt.: 4°C
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Transparency: 2-3/7, Seeing: 5/10
N
E
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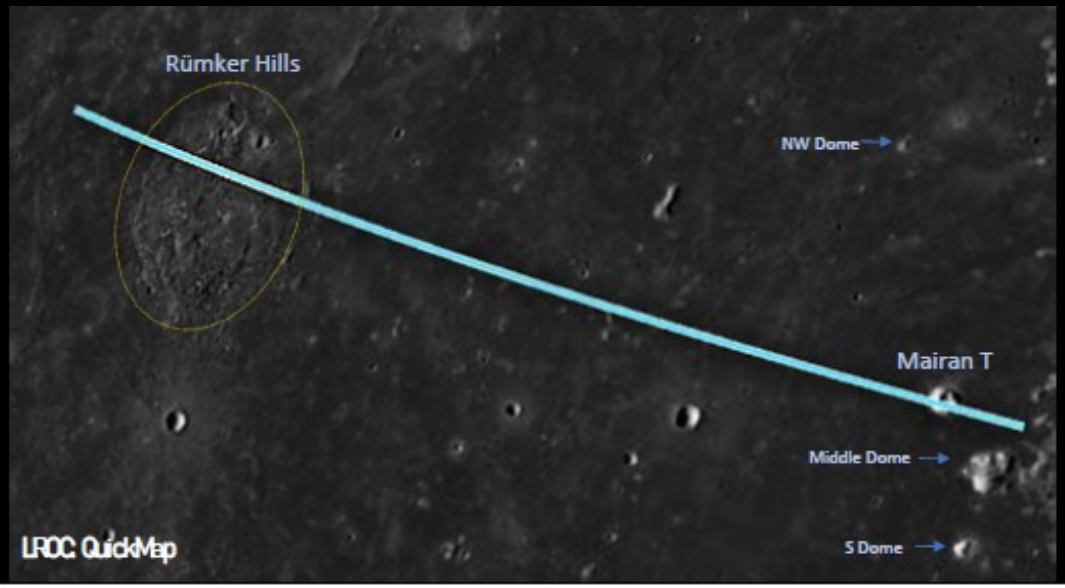
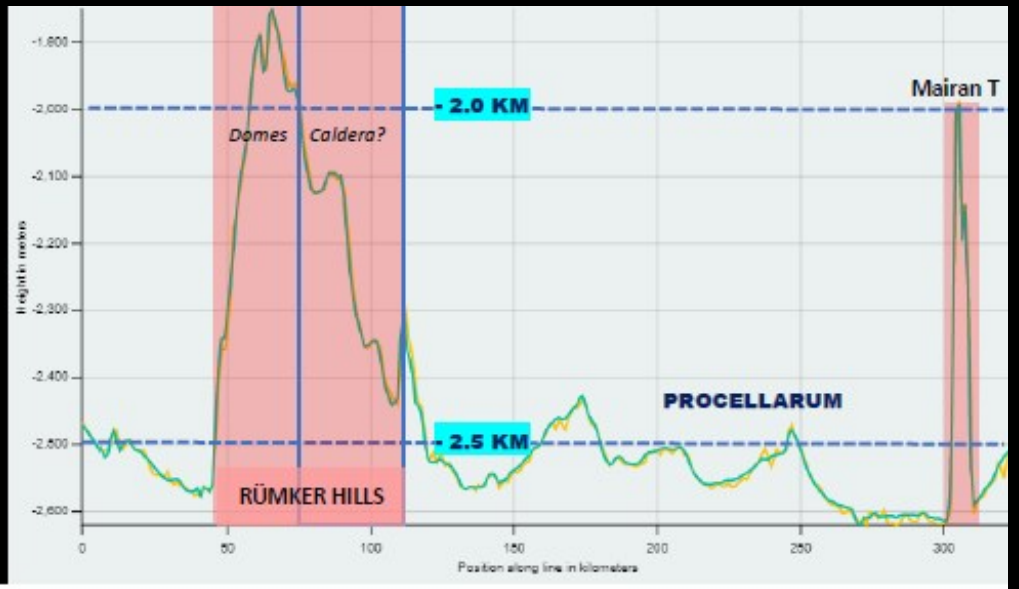
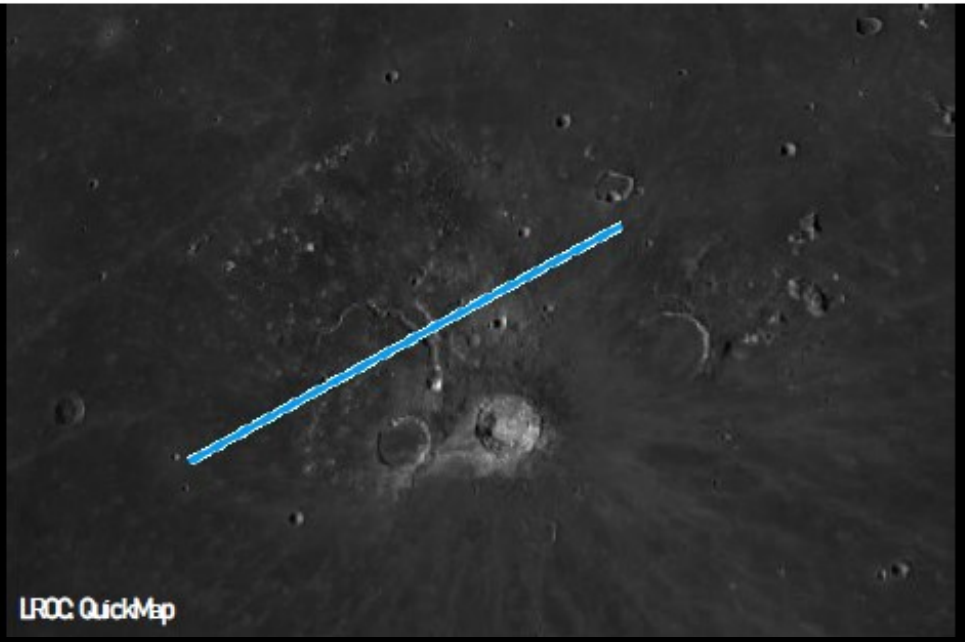
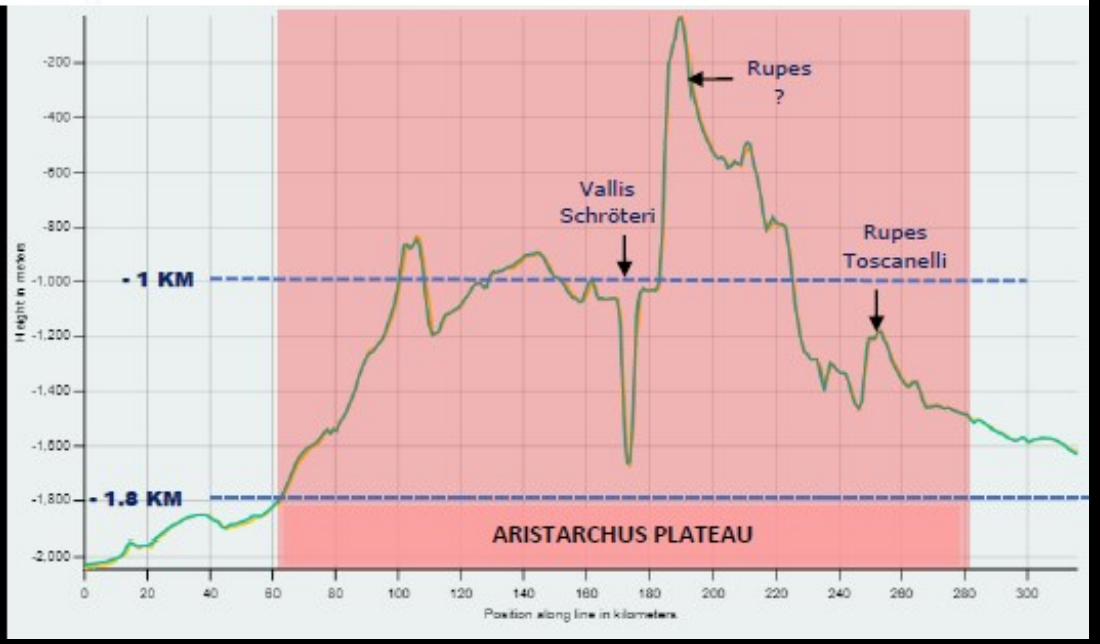
FFC @ 3½x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure
2
Aristarchus Plateau
Rümker Hills
Rima Sharp
Mairan T
uI: Mairan
γ
δ
E: Gruithuisen
Dorsum Niggli
Rimae Toscanelli
Vallis Schröteri
Cobra Head
Rupes Toscanell
Rimae Prinz
Vera
I: Prinz
uI: Herodotus
C: Aristarchus
Herodotus ω
Marius Hills
Rima Marius
E: Euler


Rümker Hills
NW Dome
Mairan T
Middle Dome
S Dome
LROC QuickMap


Mairan T
2.0 KM
Domes
Caldera?
PROCELLARUM
2.5 KM
RÜMKER HILLS
Height in meters
Position along line in kilometers


LROC QuickMap


Rupes
?
Vallis
Schröteri
Rupes
Toscanelli
1 KM
1.8 KM
ARISTARCHUS PLATEAU
Height in meters
Position along line in kilometers

13-Day Moon

More on: Aristarchus, Marius, Rainer γ

It's the start of April and I'm out a couple of early evenings in a row for high magnification observations of the **~13-Day waxing gibbous Moon** towards the SE. The first evening (2020-04-05, 21:00) I have a **12.4-Day** ~ 92% Moon at 36° altitude below *Leo*, while the second evening the Moon is **13.7**-Day ~ 97% and a bit lower at 25% altitude in *Virgo*. The temperature is a comfy (for the season) 7-8°C, and the first night the humidity is delightfully low (67%, dew-pt. 1°C), but there's a wind of 5-8m/s that huffs & puffs at my small refractor. On the second night, a front zone is passing with higher humidity (89%, dew-pt. 7°C), and though the wind has abated a bit to 3-5 m/s, the seeing is considerably worse than the previous night.

2a

There are several interesting formations along the 13-Day lunar terminator, so although the transparency and seeing these two evenings are solidly below medium, I push ahead with my observations and record my results, -- which I'll hereby share with you. My area of interest the 1.st night are the two **volcanic complexes: the Aristarchus plateau and the Marius hills.**

The **Aristarchus plateau** is clearly seen as an uplifted diamond-shaped block covered by dark pyroclastic ash from the *Cobra Vent* and with several sinuous lava rilles (*Schröter, Toscanelli*) winding out of the plateau towards the N and W. To the NE is seen the *Prinz* crater with more lava channels (*Rimae Prinz*), and S of Herodotus is the *Herodotus Omega* volcanic dome.

South of the Plateau is another uplifted mare crust area with ~300 small pyroclastic ash cones, and a long sinuous rille (*Rima Marius*) is winding up N towards *Aristarchus*. This is known as the **Marius Hills**.

The two young Copernican craters **Kepler and Aristarchus** have both splashed out a bright web of ejecta rays across *Mare Imbrium*

2b

Rainer Gamma

Last night I observed the volcanic *Aristarchus* and *Marius* formations, so tonight I continue further S from the *Marius Hills*, where I encounter the young Eratosthenian craters: **Rainer and Cavalerius**. Further SE along the lunar terminator is seen some large old pre-Nectarian (*Grimaldi, Riccioli*) and Nectarian (*Lohrmann, Hevelius*) craters.

Just W of Rainer is the peculiar bright albedo swirl: Rainer Gamma, showing a central dipolar magnetized oval with a long, twisted tail up NE towards the Marius Hills plus fragments of a broken-up tail down SW along Cavalerius. It is thought that the strong local magnetic field (magcon) has deflected the solar wind, thereby reducing the space weathering and preserving the original high surface reflectance; What created the magnetic anomaly is still unknown.

There are some interesting rille systems in this area too (*Rima Hevelius, Grimaldi,* and further south: Sirsalis), but the bad seeing tonight bounces around the field of view like a bag of Mexican Jumping Beans, thus reducing the contrast to such a degree that I can't see the rilles...It is thought that the strong local magnetic field (magcon) has deflected the solar wind, space weathering and preserving

2c

Schiller-Zucchius

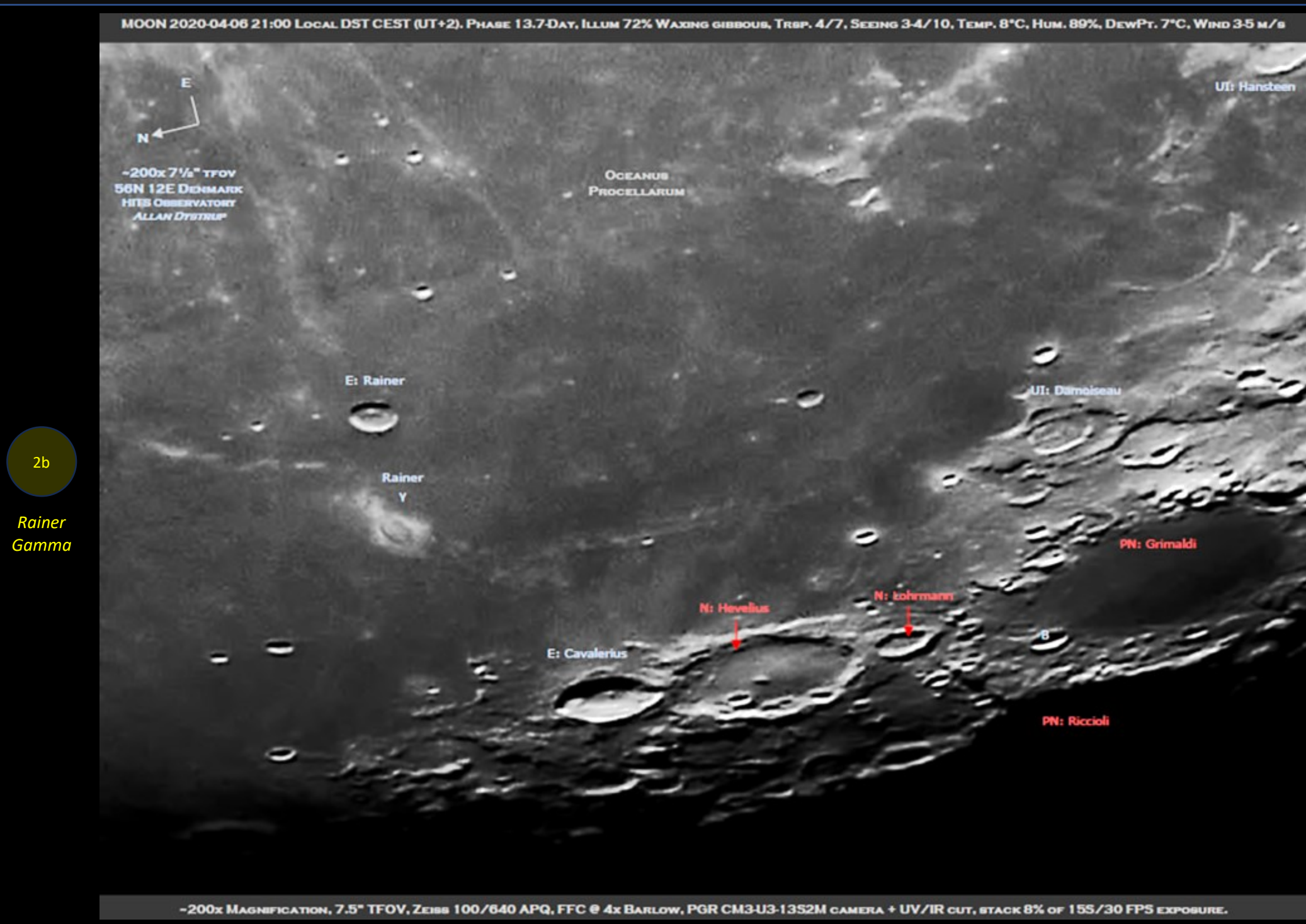
Besides the interesting volcanic and magnetic features at the terminator of the 13-day Moon, the Southern Highlands also offer a good view of the ancient pre-Nectarian Schiller-Zucchius Basin with surrounding mostly Nectarian and older craters (Hainzel, Mee, Schickard, Wargentin, Phocylides, Bailly, Scheiner).

The unusual oblong Schiller formation is probably the result of an oblique impact of a large but broken-up projectile that made a series of elliptical, overlapping and nearly simultaneous craters (See John Moore's excellent discussion here: https://www.cloudynights.com/topic/701442-schiller-crater-an-animated-view/?p=10101039).

I'm thinking the small shallow crater connected to Schiller at the SE end may also have been formed in this cluster-impact?

2a

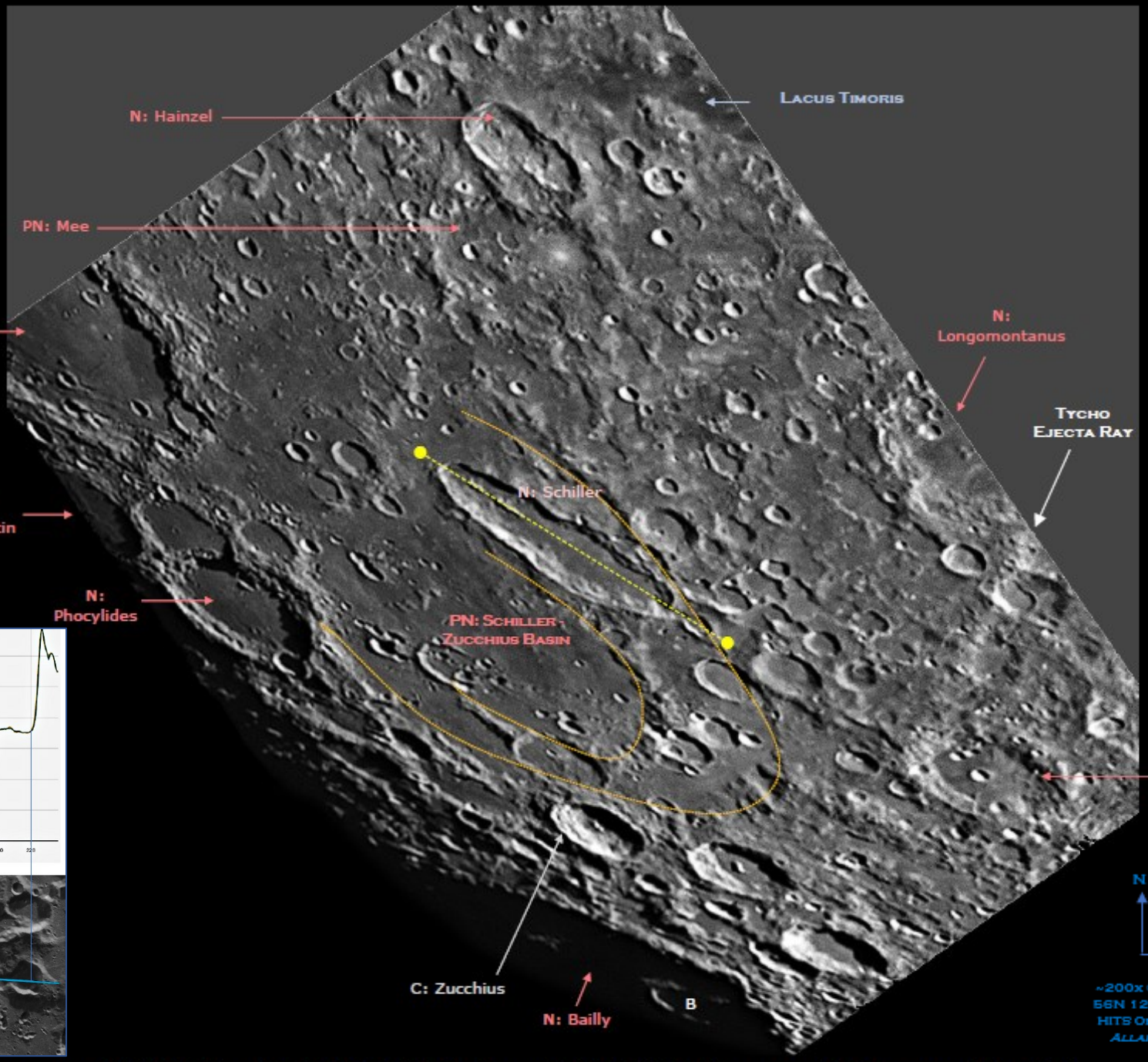
Aristarchus & Marius

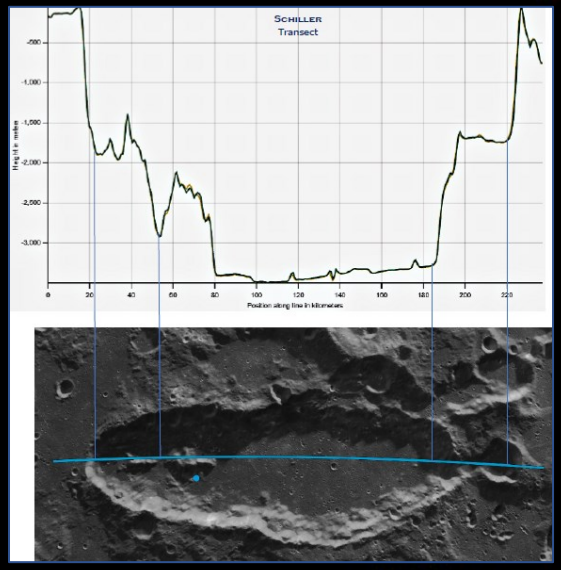


2b

Rainer Gamma

MOON 2020-04-05 21:00 Local DST CEST (UT+2). Phase 12.4-Day, Illum 92% Waxing gibbous, Trsp. 5/7, Seeing 6-7/10, Temp. 7°C, Hum. 67%, DewPt. 1°C, Wind 5





~200x @ 7.6" TFOV
56N 12E Denmark
HITS Observatory
Allan Dysterup

~200x Magnification, 7.5" TFOV, Zeiss 100/640 APQ, FFC @ 4x Barlow, PGR CM3-U3-1352M camera + UV/IR cut, stack 8% of 155/30 FPS exposure.

3

13-Day Moon close-up
Humorum.

Like the *Nectaris, Crisium* and *Serenitatis* basins, **Humorum** is from the Nectarian epoch (~3.9 Byr ago, i.e. just before the Imbrium impact. *Humorum* lacks spectacular rings (like *Nectaris* and *Crisium*), but with some effort (and a little imagination) I can discern the inner basin rim (#1: the excavation boundary), and – most visible towards the W - hints of an outer ring: #2 between the craters *Cavendish* and *Fourier*. There's also an inner "wrinkle ridge" ring: #0, marking the position of down-dropped central blocks from the basin rim, -- obvious at the E side of Mare Humorum, and continuing along the W side in the curving scarp: *Rupes Liebig*.

A defining characteristic of the Humorum basin is the significant **W-E asymmetry**, caused by the Humorum impact being located right at the western rim of the older (pre-Nectarian) Nubium basin; This has resulted in the E ring structure of Humorum being much more subdued, and to a high degree drowned and hidden below the upper Imbrian lava flooding of the basins. Some vents and lava channels from this flooding are clearly visible, such as the *Herigonius Rille* E of Gassendi (source of the dark lava surrounding and flooding Gassendi's S crater wall) and the Doppelmayer Rille N Doppelmayer (surrounded by dark ash deposits from fire-fountain vents in the rille).

After the lava filling of Humorum, the center of the Mare has subsided, causing concentric arcuate rilles along the periphery, such as the long *Rimae Hippalus* towards the SE of the Mare (between ring #1 and #2). Besides these arcuate eastern "stretch marks" from the central Mare Humorum subsidence, I can also along the W side of the basin see a network of long linear rilles: the *Rimae Mersenius – de Gasparis – Palmieri* system, which is radial to the Gargantuum basin (as is the Sirsalis rille), and that can be explained as parallel lava sheet subsidence creating grabens or dikes along the rim of the Gargantuum basin.

The Humorum basin is surrounded by a necklace **of large, shallow-floored Nectarian craters**, e.g., *Gassendi, Mersenius, Cavendish, de Gasparis, Palmieri, Doppelmayer, and Hippalus*. All of these exhibits some degree of floor uplifting and fracturing from underlying rising magma, most obvious in *Gassendi* and *Doppelmeyer* that show their own interesting local system of tilted lava plates, scarps and rilles.

4

13-Day Moon close-up
Tycho.

The cloud cover is getting denser now, so I hurry up and start panning my small 4" refractor further S towards the cratered highlands; I frame the view in a 9" field @ ~200x magnification, such that the large crater *Schickard* is up NW and the "diamond" of craters *Tycho-Longomontanus-Maginus-Clavius* is down towards the SE.

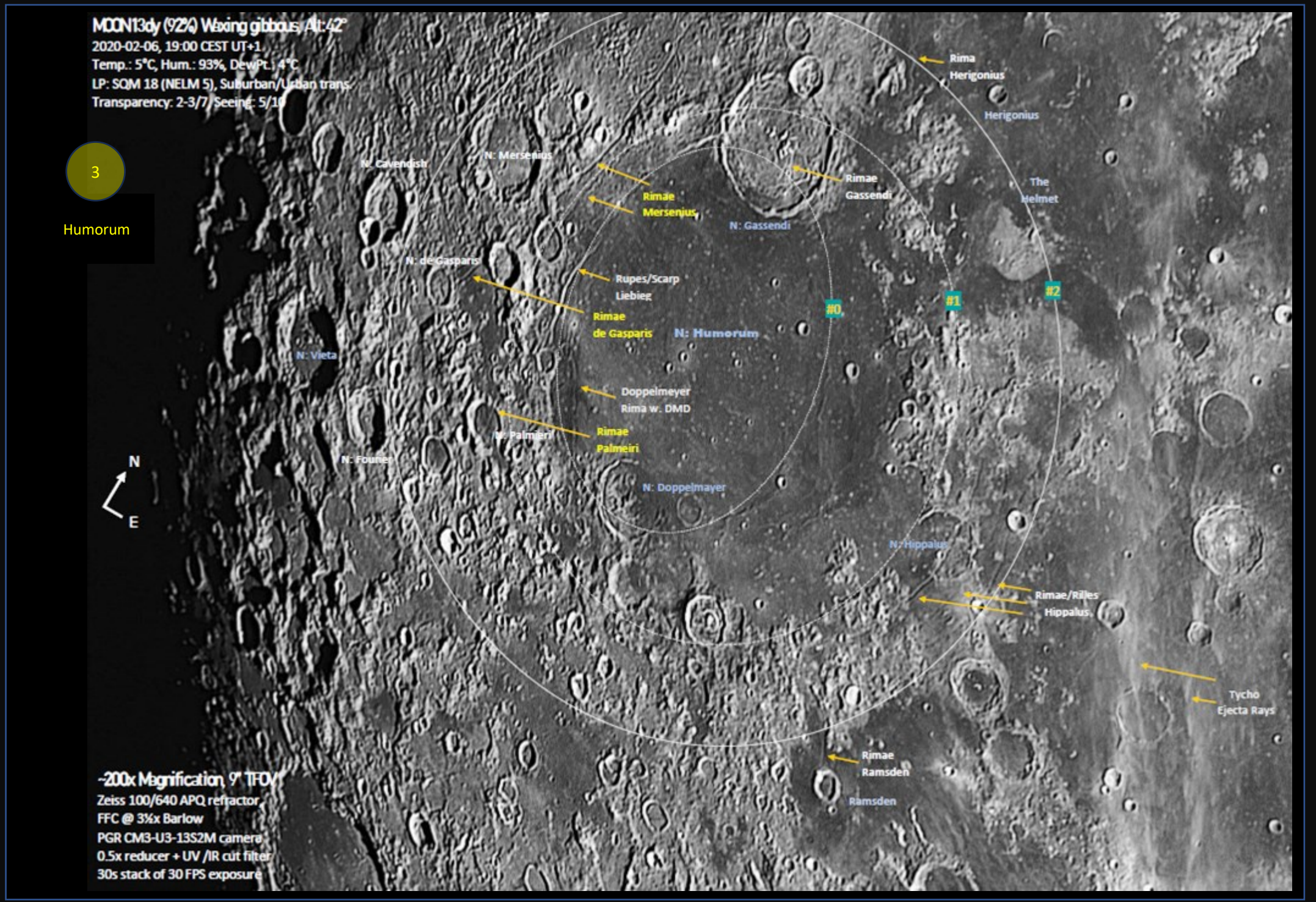
This is an interesting mosaic of lunar landscapes, with the ancient **pre-Nectarian Nubium basin** up NE, filled with Imbrian mare to an altitude of around -2.5 Km. This area shows interesting structures such as the subsidence stretch graben *Rima Hesiodus* and the small peculiar concentric ring crater *Hesiodus A*, - but I'm not going to spend much time on these tonight.

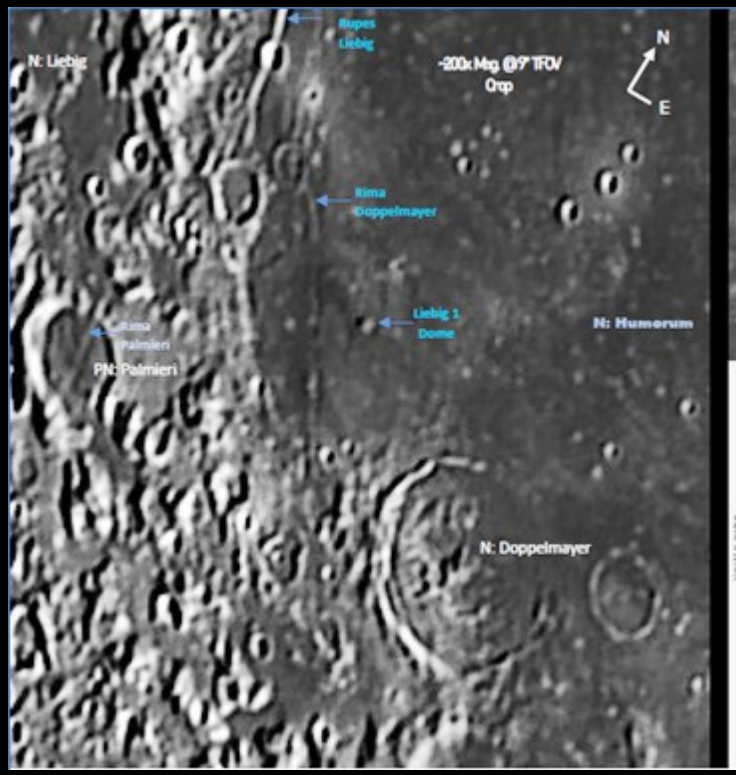
Instead, I first focus on the old, heavily cratered **highland crust towards the SE around Tycho**. This area has a mean altitude of ~0 Km, but rises to a level of ~1 KM past *Clavius* and down to the S. Pole. The highland has no pre-Nectarian basin structures (but a few highly eroded PN-craters, such as *Wilhelm, Gauricus* and *Maginus*). On the other hand, there's a multitude of younger crater excavations such as *Clavius* (depth -3 Km), with *Clavius D* reaching an astonishing depth of -5 Km. Below I've included a transect from *Pitatus* past *Gauricus* and further on to *Tycho*, illustrating the rise from the Mare Nubium level (-2½ Km) to the Highlands at 0-1 Km height.

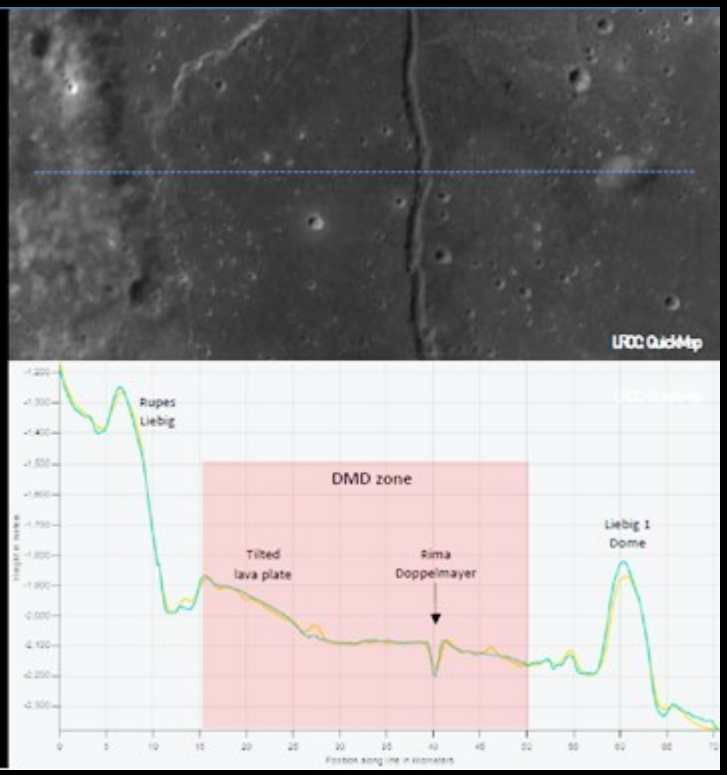
The region from the craters *Hainzel* and *Schiller* towards the SW - while still at an average height of ~0 Km – features some clearly smoother and **less cratered plains** covered by a carpet of basin ejecta from the nearby *Orientale* impact. The worn rims of several medium-sized **pre-Nectarian** basins are still visible in this area, such as the large walled plain *Schickard*, the *Schiller-Zucchius* basin and the *Bailly* basin towards SW. The walled plain of *Schickard* shows an obvious triangular wedge of light-albedo material, with darker patches to the NW and SE, – the remains of an ejecta ray thrown out by the *Orientale* impact. Also, worth mentioning here are the now almost obliterated pre-Nectarian crater S of Hainzel called: *Mee* (no kidding...). Btw, there's a probable dome in the Mee crater, which is an unusual structure in the thick crusted lunar highlands (I've marked the dome on the image below).

There's a multitude of younger **Nectarian** craters sprinkled across the field of view, notably: the crater **Wargetin** (S of *Schickard*) filled by lava, which has eventually spilled over the NW crater rim; The lava has formed a characteristic Y-shaped wrinkle ridge at the center of the crater. **Hainzel** is a complex of three overlapping craters, possibly from a simultaneous cluster impact. **Schiller** is an exceptionally elongated crater with a peculiar long central ridge in the N part, suggesting a very low angle of impact by a rock coming in from the NW.

Finally, there's the youngest **Copernican** craters such as *Zucchius* and of course *Tycho* that is totally dominating the view. The giant **Tycho** impact (a rock ~9 Km Ø) has left a 4.8 Km deep and 45 Km wide excavation (see transect), from which impact melt instantly splashed over the terraced inner wall, forming a dark ring/halo around the crater. Countless rays of excavated light-hued anorthositic crust (boulders, rocks and gravel) were flung out in all directions, but preferentially in the direction NE-E-SW, indicating that the impactor came in low (<45°) in an oblique trajectory over the Moon's W horizon. In my image below you can see two broad and bright rays: one up NW and one down SW), enclosing the downrange direction towards the E (much like the butterfly pattern seen around the *Proclus* crater at the W shore of Crisium). Magnificent!

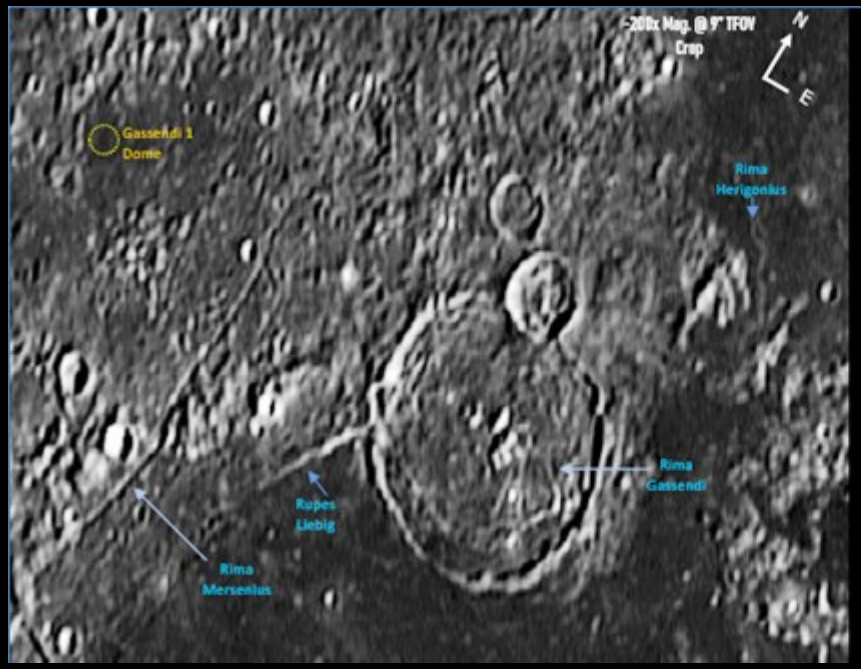

MOON 13dy (92%) Waxing gibbous; Alt: 42°
2020-02-06, 19:00 CEST UT+1
Temp.: 5°C, Hum.: 93%, DewPt.: 4°C
LP: SQM 18 (NELM 5), Suburban/Urban trans.
Transparency: 2-3/7, Seeing: 5/10
3
Humorum
Rima Herigonius
Herigonius
N: Cavendish
N: Mersenius
Rimae Mersenius
Rimae Gassendi
N: Gassendi
The Helmet
N: de Gasparis
Rupes/Scarp Liebieg
Rimae de Gasparis
N: Humorum
#0
#1
#2
N: Vieta
Doppelmeyer Rima w. DMD
N: Palmeri
Rimae Palmeiri
N: Fourier
N
E
N: Doppelmayer
N: Hippalus
Rimae/Rilles Hippalus
Tycho Ejecta Rays
Rimae Ramsden
Ramsden
~200x Magnification, 9' TFOV
Zeiss 100/640 APO refractor
FFC @ 3½x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure

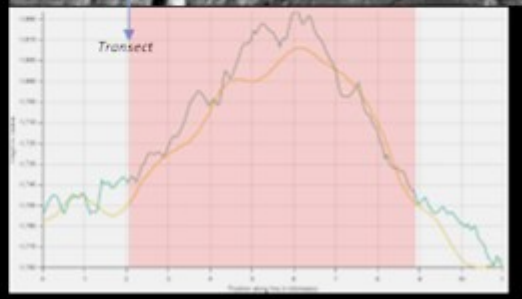




Here's a small close-up study I did of the **volcanic structures in SW Mare Humorum**; It shows the "coastal area" from the *Liebig Scarp* towards the W, past the tilted lava flow at the W shore (formed by Mare subsidence), past the relatively shallow *Doppelmayer rille* (~100m deep) from which fire fountain volcanism has coated the surroundings in dark mantle materials, and on to the volcanic dome *Liebig-1* that rises 300-400m above the mare level. This is an interesting area of Humorum.

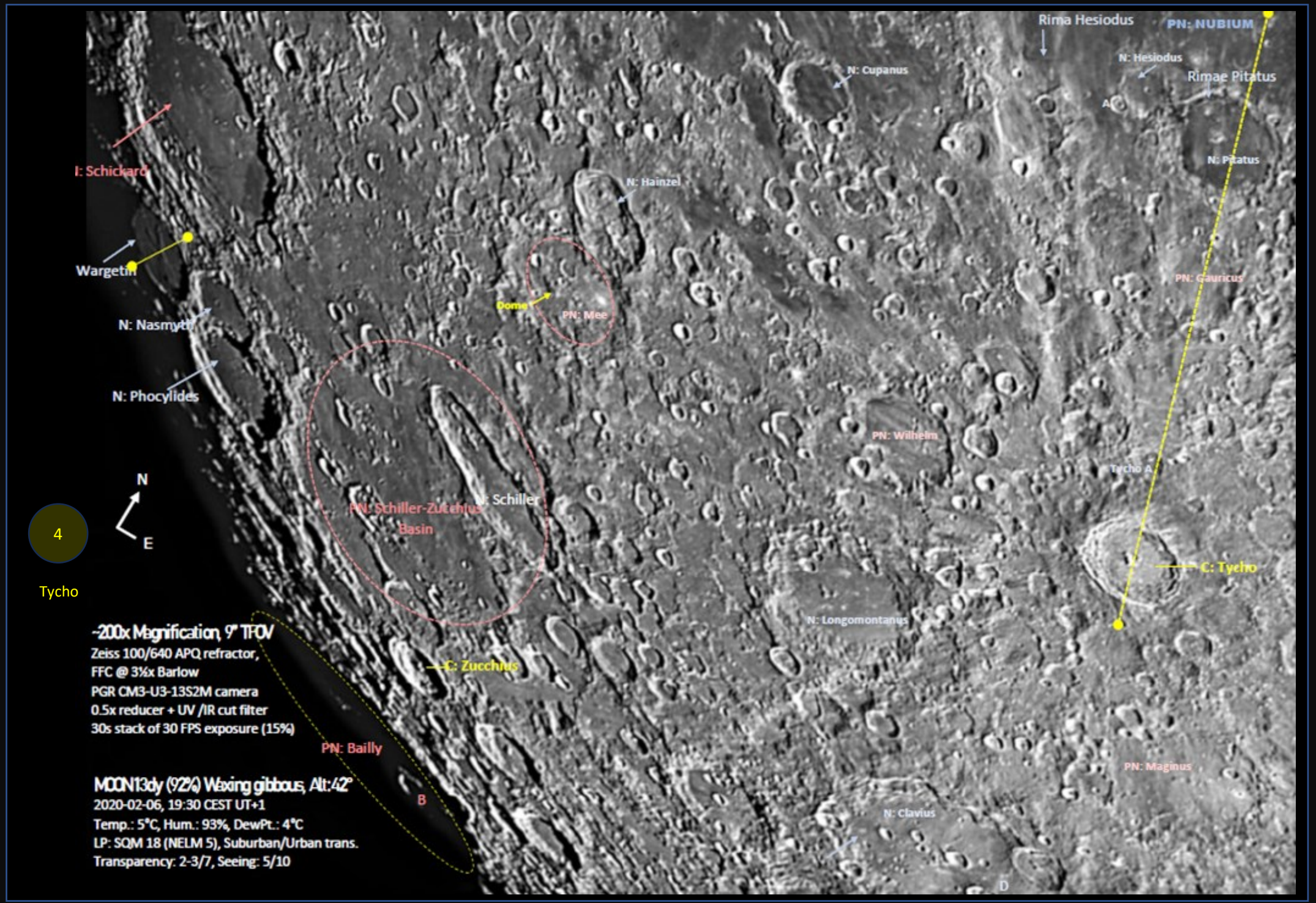
And finally - in the Humorum part of my observation - I also looked for the Gassendi 1 Dome (marked on the image below), -- but I was not able to see it. It is a rather flat shield volcano (Height:100m, Width: 7Km) that requires high magnification, low sun and good seeing...

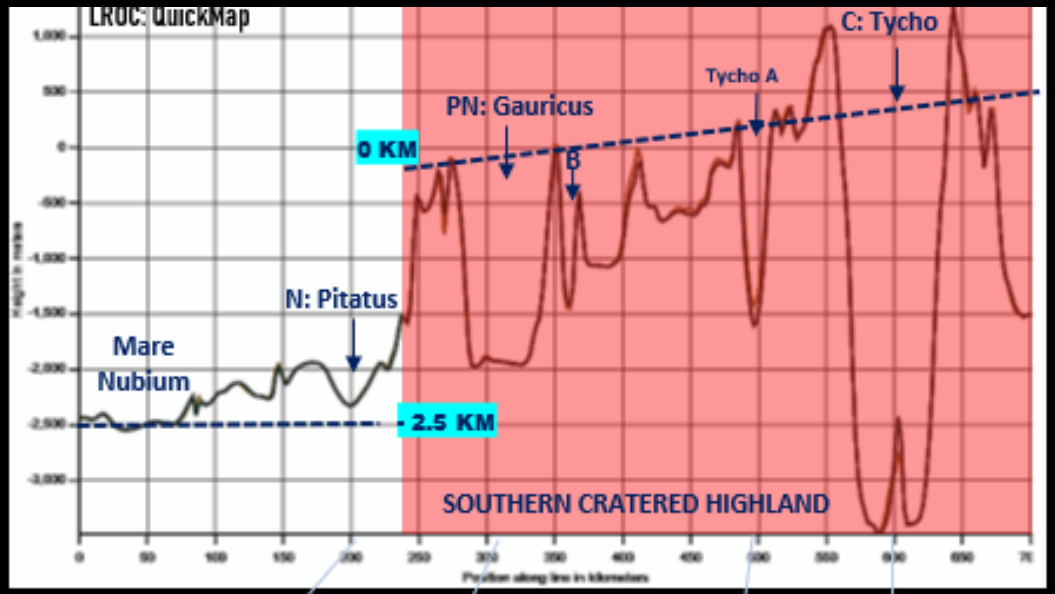


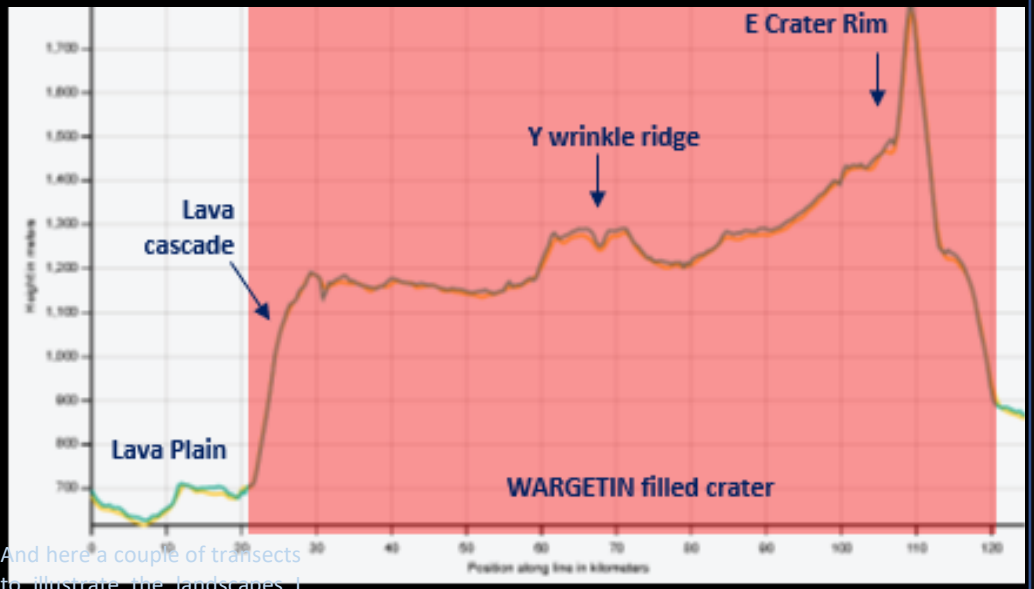


G1 Dome

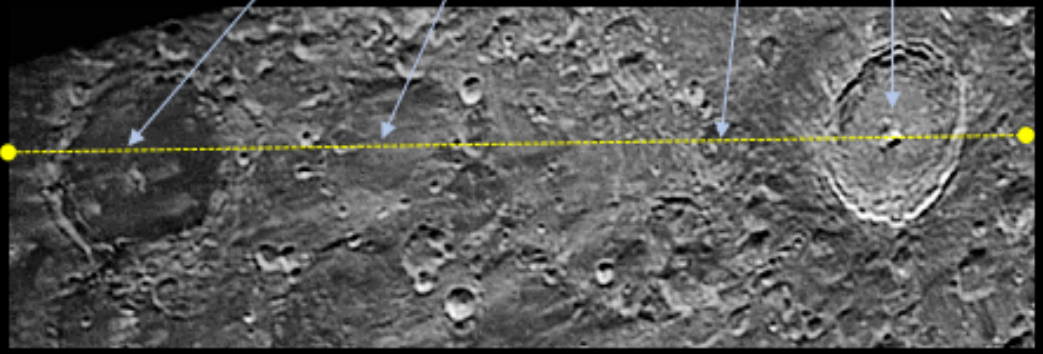
Height 100m
Width 7 Km


Rima Hesiodus
PN: NUBIUM
N: Cupanus
N: Hesiodus
Rimae Pitatus
A
N: Pitatus
I: Schickard
N: Hainzel
Wargentin
PN: Gauricus
Dome
PN: Mee
N: Nasmyth
N: Phocylides
PN: Wilhelm
Tycho A
N
E
PN: Schiller-Zucchius Basin
Schiller
4
C: Tycho
Tycho
N: Longomontanus
~200x Magnification, 9' TFOV
Zeiss 100/640 APQ refractor,
FFC @ 3½x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure (15%)
C: Zucchius
PN: Bailly
PN: Maginus
MOON13dy (92%) Waxing gibbous, Alt:42°
2020-02-06, 19:30 CEST UT+1
Temp.: 5°C, Hum.: 93%, DewPt.: 4°C
LP: SQM 18 (NELM 5), Suburban/Urban trans.
Transparency: 2-3/7, Seeing: 5/10
B
N: Clavius
D



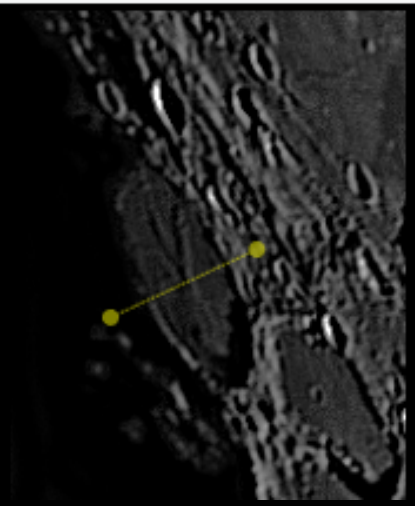


And here a couple of transects to illustrate the landscapes I observed in the Tycho region



13-Day Moon, -200x @ 9" TFOV
2 Crop

Zeiss 100/640 APQ refractor,
FFC @ 3½x Barlow
PGR CM3-U3-13S2M camera
0.5x reducer + UV /IR cut filter
30s stack of 30 FPS exposure




14-Day
MOON