
9-Day
MOON

The Moon, age ~9 days.

It's an early evening in the **start of January** (2020-01-04, 17:30), and I'm out, setting up my small telescope in astronomical dusk, to study **the 9 days waxing moon (64% illuminated)** up at a good 36° altitude above the SSE horizon, in southern *Pisces*. The temperature is a cool 3°C with a relatively low humidity of 61%, and the dew point is way down at -4°C. The LP is a Bortle 5/6 bright/suburban (aka. NELM 5.6 ~ SQM 19.0), and the transparency is medium at 3-4/7 with a faint moon halo from high Cirrus, whereas a train of low drifting Cumulus Humilis have now been swept down south and are thus well out of the way. The seeing is a moderate 5-6/10, with a medium wind from the NW interrupted by intermittent stronger gusts that can "shake, rattle and rock-n-roll" my small 100/640mm refractor, although it is solidly mounted on my sturdy Zeiss Ib tripod.

I've now set up my telescope, initially for a **full disc view of the Moon at 98x magnification in a 1° FOV (4" f/6.4 refractor w. 2x barlow + 13mm 100°AFOV EP). The max libration is in deep lunar night up NW (+7° lat., +4° long.), but this evening I'll be focusing on the terminator area of the 9-day half Moon, which crosses from the central Imbrium basin down south through the central Nubium basin, and thus offers a favorable view of:**

On the N hemisphere:

- The *N- Polar highland* region, from the crater pair *Goldschmidt* (pre-Nectarian)-*Anaxagoras* (Copernican) and up N past the craters *Scoresby* and *Byrd-Peary* to the pole.

- The E *multi-ring Imbrium sculpture* (3.8 Byr) including:
    - The inner concentric *mare ridges*, which borders to the E on the partly submerged peaks of the inner ring (#1): from the *Straight Range*, past Mts. *Tenerife, Pico, Spitzbergen* and *Archimedes.*
    - The topographic *basin rim*, which is the probable excavation boundary (#2), from the Mts. *Alpes* past the *Caucasus* to the *Apennines* and *Carpathians* and possibly past the mostly buried Mts. *Harbinger* (now in deep night W of the terminator).

- The *regions bordering on the Imbrium basin* to the N and S are both located inside the excavation of the older (pre-Nectarian) and larger *Procellarum* basin, and as such they were lava covered in the upper Imbrian epoch:
    - The N trough outside the Mts. Alpes is now seen as the lava-filled *Mare Frigoris* moat, while
    - The S trough outside the Mts. Apennines is filled with the *Sinus Vaporum-Aestuum* lava plains that harbor the volcanic *Bode* and *Aestuum* pyroclastic areas.

1 *The Moon, age ~9 days, N area.*

I now crank up the magnification **to 122x in a 0.8° TFOV** (FFC@4x barlow+ 21mm EP); This gives me a good view of the lunar terminator, first through the N and thereafter the S hemisphere. In the images below, I've included the appropriate segments of the *Wilhelms-McCauley* lunar geology map from 1971 as an illustration of the origin of the main terrain features; Note that this source presents a more detailed interpretation of the **Imbrium basin morphology** with 3 rings: the inner concentric wrinkle-ridge ring #1, an intermediate ring #2 (1.200km Ø) through the *Mts. Alpes* and *Archimedes*, plus an outer basin rim ring #3 (1.500km Ø) from the *Mts. Carpathian* up through the *Apennines* and continuing along the *Caucasus* to enclose *Mare Frigoris* towards the N.

There is thus some ambiguity as to the true excavation boundary and topographic rim of the Imbrium protoplanet impact basin, especially in the NE and SW sectors. Apollo rock analysis has showed that the *Apennine Bench* (S of Archimedes) is -- at least partly -- of igneous origin (KREEP), erupted ~3.84 Byr ago on the basin floor shortly after the Imbrium impact, and thus the Mts. Archimedes may not be uplifted crust in a #2 basin ring, but rather of endogenic origin combined with slumps from the Apennine scarp, which would favor the 2-ring interpretation.

The area immediately SE of the Carpathian-Apennine Imbrium rim has been covered by a thick, hilly carpet of light-hued basin ejecta with radial SE tapering lineate structures of rocky hummocks and wedges of melt deposits, in which the lower regions have later (in Upper Imbrian) been partly flooded by small lava lakes (*Sinus Vaporum*, *Aestuum* etc.). This area has experienced tremendous stress in connection with the crust uplifting, and that shows up in several tectonic straight rilles (grabens) as well as volcanic sinuous rilles (collapsed lava channels and uplift fractures); This is the region that Charles Wood called "*Rilleland*". In particular, *Sinus Aestuum* shows prominent areas of fine volcanic ash and glass deposits from explosive fire fountain volcanism (dark mantle deposits: DMD), notably towards the E shore (*Bode* pyroclastics) and the S shore (*Aestuum* pyroclastics). The DMD layer probably continues from the *Bode* and *Aestuum* areas, west to S of *Copernicus*, but here it has been partly covered by upper Imbrian lava flooding with Eratosthenian and Copernican ejecta on top.

1

MOON 9Day (64%) Waxing Half, Alt:36°

2020-01-04, 17:30 CEST UT+1, Astronomical dusk
Temp.: 3°C, Hum.: 61%, DewPt.: -4°C
LP: SQM 19 (NELM 5.6), Bright/Suburban trans.
Transparency: 3-4/7 high haze, Seeing: 5-6/10 windy

N. Polar Highlands
NORTH IMBRUM
IMBRIUM
SOUTH IMBRUM
NUBIUM
S. Polar Highlands

P: Goldschmidt
C: Anaxagoras
HUMBOLDTIANUM
PROCELLARUM
FRIGORIS
SERENITATIS
MARGINIS
Vaporum
Aestuum
Medii
COGNITUM
C: Tycho
P: Maginus
C: Clavius

98x Magnification, 1° TFOV
4" f/6.4 refractor, 21mm ETH EP
iPhone XS, NightCap v 9.7 App

MOON 9Day (64%) Waxing Half, Alt:36°

2020-01-04, 17:30 CEST UT+1, Astro. dusk
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122x Magnification, 0.8° TFOV

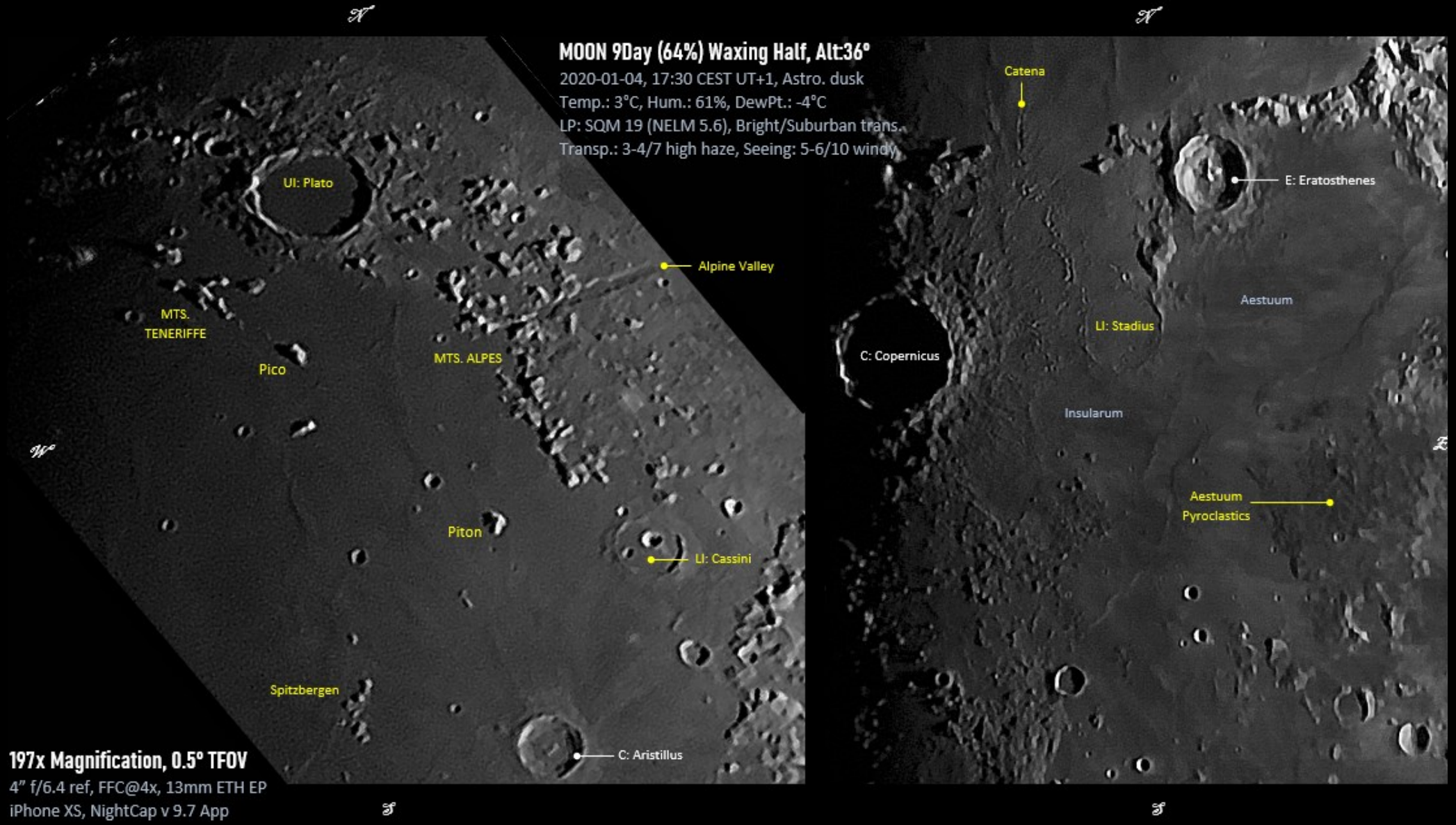
4" f/6.4 ref, FFC@4x, 21mm ETH EP
iPhone XS, NightCap v 9.7 App

Imbrium, closer up.

Here's a couple of **closer-up views** (~200x @ 0.5°) from my observation of the **9-Day moon**:

- ***Left***: The N part of Imbrium with the *Alpes Mountains* and the long *Alpine Valley* graben, and
- ***Right***: The S Imbrium region around *Sinus Aestuum* with DMD pyroclastics and the hummocky Copernicus ejecta carpet draped over Mare Insularum.

There's a long crater chain (**catena**) winding south between Copernicus and Eratosthenes, down to the almost submerged lower Imbrian crater: *Stadius*. I assume this is secondary craters from the Copernicus impact, -- or??



Sinus Aestuum

Mare Imbrium, South, 9dy

A break in the cloud cover yesterday, so I seized the opportunity to have a closer look at the **south Imbrium basin called *Sinus Aestuum***, the *"Seething Bay"* (or "Bay of Billows", as Rükl poetically call it).

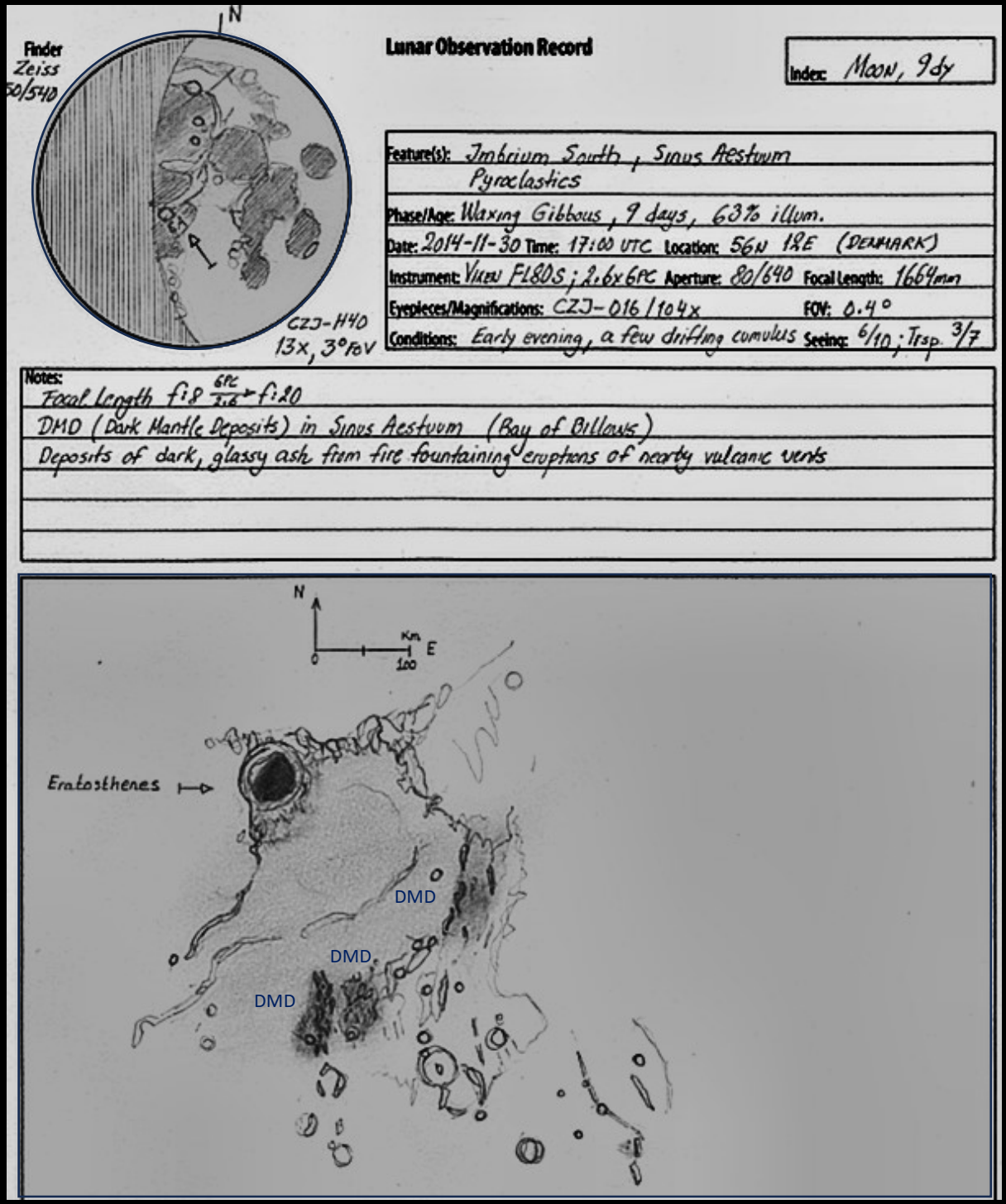
This is an interesting area with several **"DMD" (Dark Mantle Deposit) pyroclastic areas** : plains and hills covered in dark ash from fire fountaining eruptions of nearby Vulcanic vents. Extended areas with "dark matter" were clearly seen in my classic **80mm Vixen refractor**, noticeably N of Scrhröter and E of Bode C.

Also, a smaller (ca. 20x20km) distinctly dark area south of the E part of the Hyginus Rille. -- Afterwards I checked with Rükl, and he shows a pair of domes / shield volcanoes in this small area, which I guess would be the source of the ash eruptions. I didn't see (or look for) these in my 80mm, but I plan to do so next time I get the chance (and possibly bring out my 100mm classic refractor too) !

A knowledge of the geological processes that shaped the moon ,really does add an extra dimension to the understanding of the evolution and current morphology of the landscapes, we can observe up there.

Knowing specifically where to look and what to look for, greatly increases the excitement and fun of lunar observation, -- at least in my experience. Here are some of my inspirational sources:

- Moon 101, NASA Johnson Space Center
  https://www.youtube.com/watch?v=vVwLr-1XfyA
  A series of YouTube videos on lunar topology and geology.
  At the same time educational and entertaining !
- The Modern Moon: A Personal View, Charles A. Wood (Book)
  https://www.amazon.com/The-Modern-Moon-Personal-View/dp/0933346999
  The best source I know of for a comprehensive and coherent description and analysis of the formation and current appearance of lunar landscapes.
  Warmly recommended. -- Problem is that it's out of print, and the price is high. (I have a spare, new copy for $185, -- you should be able to get a used one for le$$)
- Photographic Moon Book, Alan Chu (PDF)
  http://www.alanchuhk.com/
- Selenology Today (journal, PDF)
  https://www.lunar-captures.com/SelenologyToday.html



2

The Moon, age ~9 days,
S area.

Moving on to **the** S hemisphere of the 9-Day half-moon, we first encounter

The light-colored highland crust of **the "Great Peninsula"** (D. Alter);
Towards the W, the Peninsula is mostly covered by impact ejecta from the Imbrium basin (the planar melt-rich *Cayley* stratigraphy), while towards the E, the Imbrium ejecta has been mixed up with deposits from the underlying Nectaris basin (the furrowed *Descartes* stratigraphy). The Imbrian origin of much of the surface material on the Peninsula is evident from the system of groves and chains of secondary impact craters radiating from the Imbrium Basin (the *"Imbrium Sculpture").* The W part of the Peninsula is dominated **by large, complex craters:**

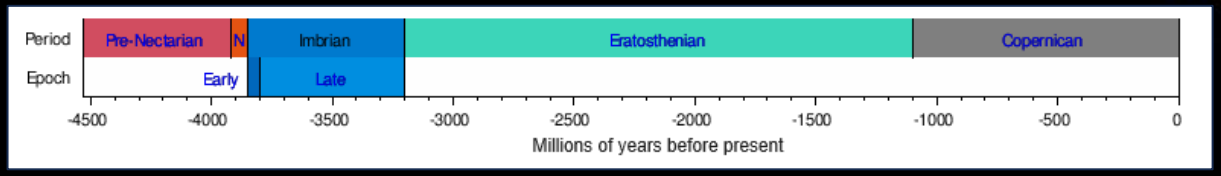
- first the old Pre-Nectarian *Hipparchus, Ptolemaeus, Purbach* and *Ancient Thebit* (with the Straight Wall), the last one partly covered by lava on the border to Mare Nubium.
- Then the younger Nectarian "triple-A" craters: *Albateginus, Alphonsus* (with several DMD patches) and *Alpetragius* (with the Egg-in-Nest rounded peak).
- Finally, we come to the youngest (lower Imbrian) crater *Arzachel*, with its spectacular 1km high and steeply terraced walls.

Panning further S, we encounter the ancient pre-Nectarian **"Southern Cratered Highlands",** with a multitude of craters on top of other craters. The most obvious landmark in the region below Nubium is the "diamond" arrangement of large complex craters marked by *Tyco* to the N and *Clavius* to the S, and with *Longomontanus* and *Maginus* to the W and E respectively.

On the S hemisphere we find:

- The old *pre-Nectarian Nubium basin* is seen flanked on the E shore by the *"Great Peninsula"* (as Dinsmore Alter named it), with the prominent large complex craters *Ptolemaeus - Albateginus, Alphonsus, Arzachel* and *Purbach*.
- The *S-Polar highland* features a multitude of craters, including the prominent "diamond" pattern from *Tycho* past *Longomontanus – Maginus* to *Clavius* towards the S.

It's now well past 18:00^{h} and I'm thus into proper astronomical night; As I start to click up the magnification, more details are revealed in these lunar areas.



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2

Imbrium Sculpture

MEDII

P: Hipparchus

P: Ptolemaeus

N: Albateginus

N: Alphonsus

N: Alpetragius

NUBIUM

U: Arzachel

P: Ancient Thebit

w/ I: Rupes Recta

P: Purbach

P: Deslandres

C: Tycho

N: Longomontanus

P: Maginus

N: Clavius

122x Magnification, 0.8° TFOV

4" f/6.4 ref, FFC@4x, 21mm ETH EP

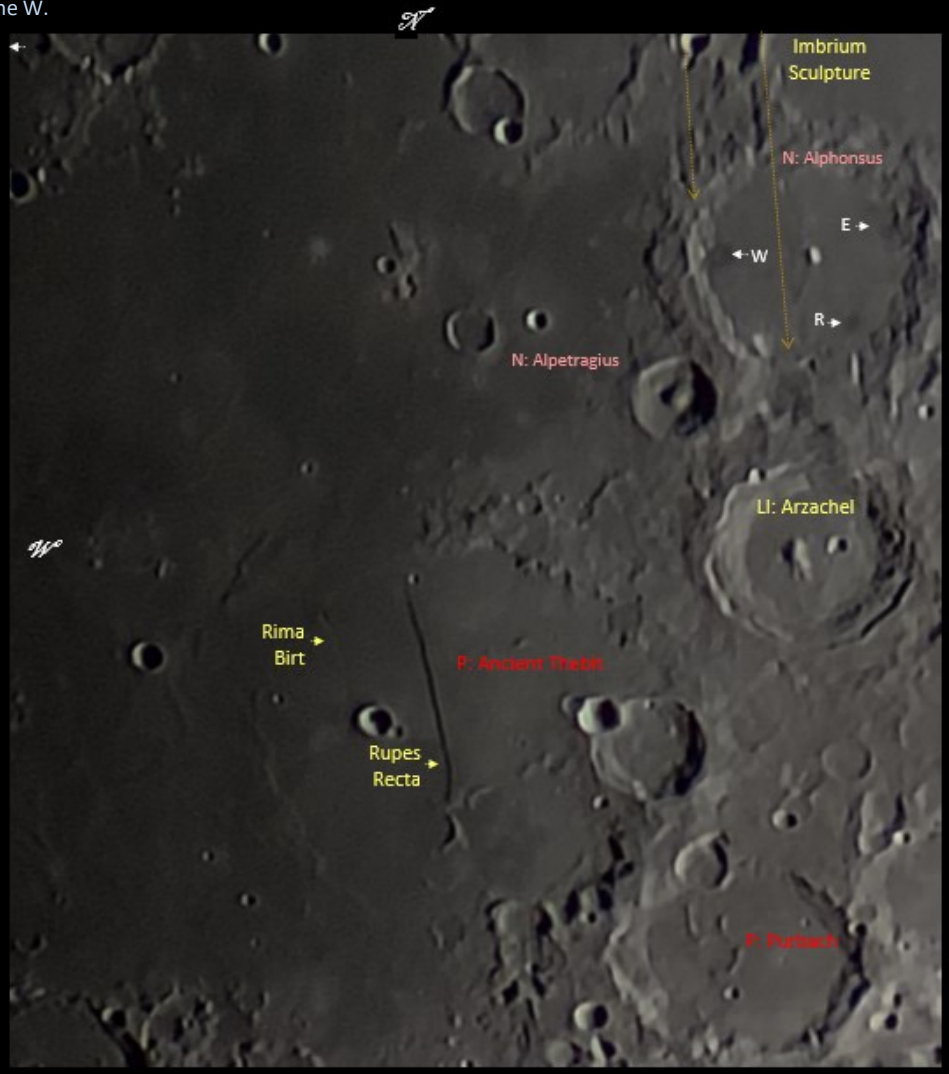
iPhone XS, NightCap v 9.7 App

The Great Peninsula & S. Cratered Highlands, closer up.

Here are a couple of closer-up views (~200x @ 0.5°) from my observation of the 9-Day moon, south hemisphere.

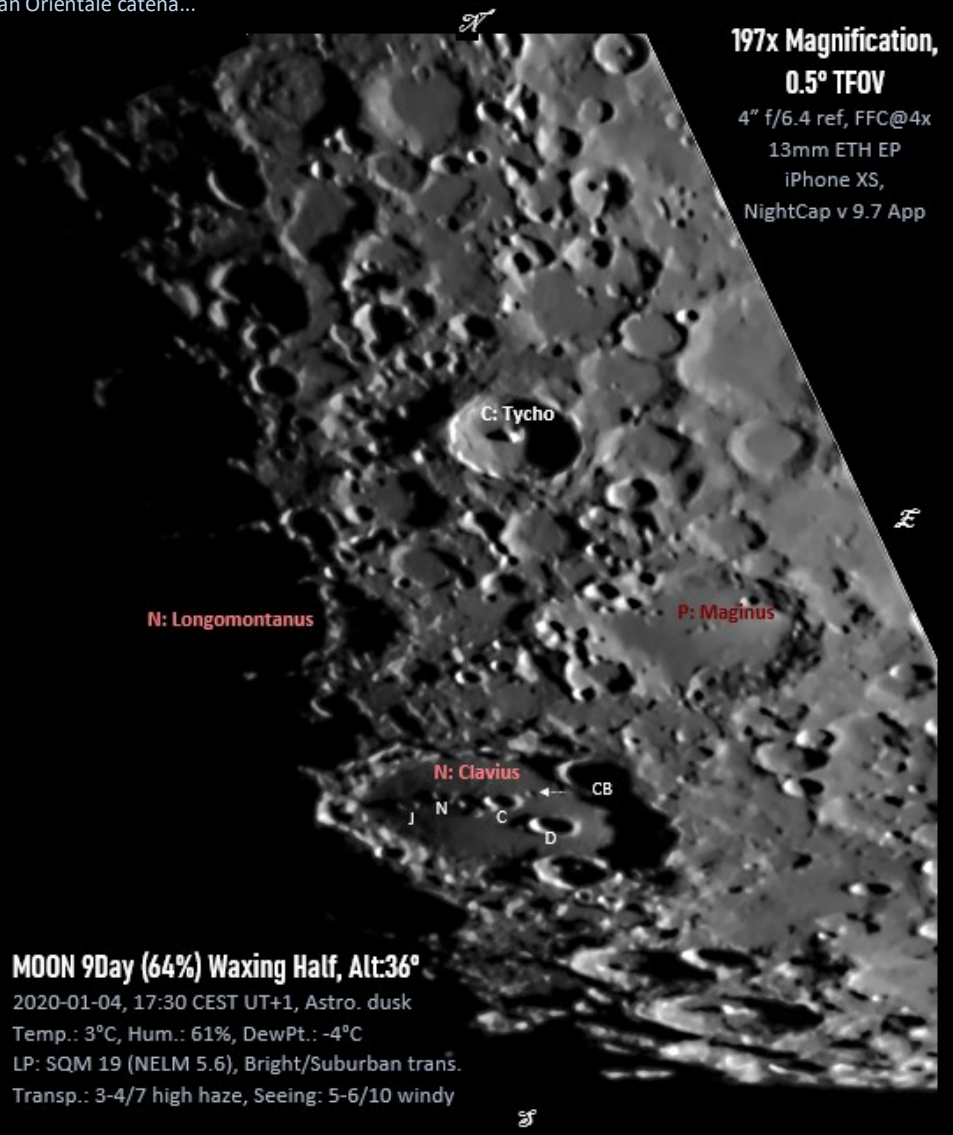
To the left: the **W part of the "Great Peninsula"**,
First focusing on *Alphonsus* which shows a N-S diagonal ridge of Imbrium ejecta, a couple of later (Eratosthenian?) W and E pyroclastic deposit areas plus a dark haloed crater 'R' towards the south.

Furthermore, in the pre-Nectarian lava-drowned crater *Ancient Thebit* is seen the 400m high scarp *"the Straight Wall"* which is a fault created by Mare Nubium subsidence after the lava flooding in upper Imbrian. I can also *just* glimpse *Rima Birt*, a collapsed lava channel running parallel to the Wall a little to the W.



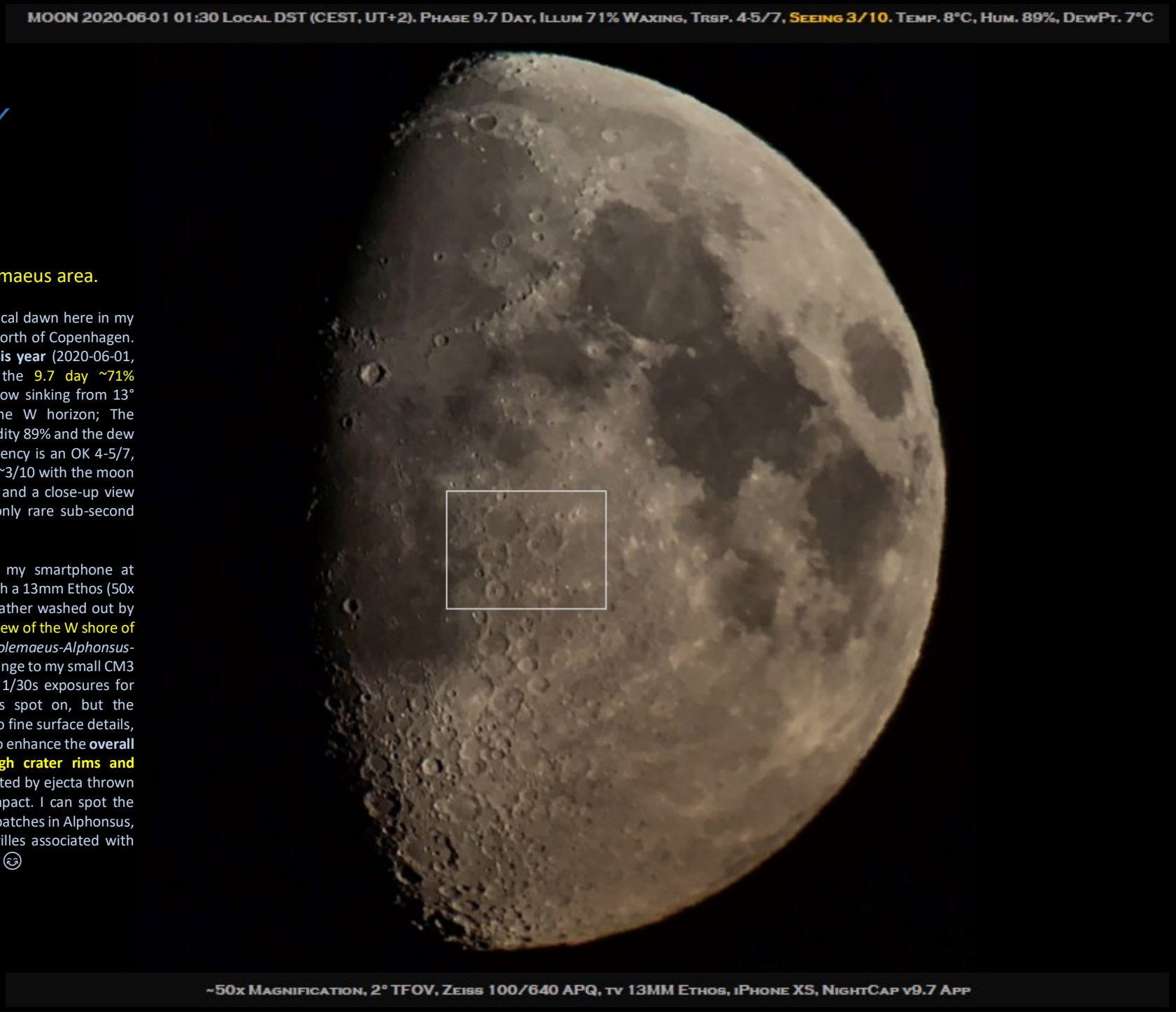
To the right: in **the rugged S Cratered Highlands** Copernican ***Tycho*** and Nectarian ***Clavius*** stand out, the latter with an arc of craters, from large D (28Km Ø) to small J (12 KM Ø), plus minute CB (9Km Ø).

A basin size impact will first throw out large, early-arriving clots of ejecta in relatively low ballistic trajectories, which will create secondary craters up to a great distance (>1000Km) from the basin. This shows up as elliptical pits, chains and furrows/gouges radial to the basin center (the *basin sculpture*). The first wave is shortly followed by a slower-moving ground surge of a finer, coarsely textured blend of impact melt and crust debris (the *ejecta blanket*), which will gradually thin out to more smooth plain deposits that partly overruns/ overlays the sculpture closest to the basin rim. Scattered Imbrium secondary craters can today be found > 3000Km from the basin center, and so the crater chain in Clavius could in theory be an Imbrium basin catena, -- but it is not radial to this basin. It is in fact more radial to the Orientale basin, and I believe I've read somewhere that it may probably be an Orientale catena...




10-Day
MOON

10 DAY MOON



Imbrium sculpture, Ptolemaeus area.

It's close to solar midnight in nautical dawn here in my suburban backyard at 56N 12E, just north of Copenhagen. I'm out in the **first summer night this year** (2020-06-01, 01:30 local DST, UT+2) to study the 9.7 day ~71% illuminated waxing moon, which is now sinking from 13° altitude in Virgo down towards the W horizon; The temperature is a comfy 8°C, the humidity 89% and the dew point is close by at 7°C. The transparency is an OK 4-5/7, but the seeing is not good at all, only ~3/10 with the moon edge undulating already at 50x mag. and a close-up view waving rather wildly at 200x, with only rare sub-second glimpses of sharp surface details.

I snap an overview image using my smartphone at 1/150s & ISO24 on my 4" refractor with a 13mm Ethos (50x @ 2° FOV), -- which however is still rather washed out by the seeing. I decide to try a close-up view of the W shore of the *Great Peninsula*, including the *Ptolemaeus-Alphonsus-Arzachel* and *Albateginus* craters. I change to my small CM3 machine-cam for lucky imaging with 1/30s exposures for 15s (200x @, 7.5") The contrast is spot on, but the resolution is..., well awful! I can see no fine surface details, but in an interesting way, this seems to enhance the **overall surface-sculpture of furrows through crater rims and troughs across the highlands**, all created by ejecta thrown out radially by the Imbrium basin impact. I can spot the three largest dark fire-fountain mare patches in Alphonsus, but not the volcanic craterlets and rilles associated with these. – I must try again another time 😊


MOON 2020-06-01 01:30 Local DST (CEST, UT+2). Phase 9.7 Day, Illum 71% Waxing, Trsp. 5/7, Seeing 3/10. Temp. 8°C, Hum. 89%, DewPt. 7°C
PN: Ptolemaeus
A
N: Albateginus
N: Alphonsus
N: Alpetragius
LI: Arzachel
~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.