

ASTR/GEOL-2040: Search for life in the Universe: Lecture 21

- Water on Mars
- Detection method
- The eons of Mars

Axel Brandenburg

(Office hours: Mondays 2:30 – 3:30 in X590 and

Wednesdays 11-12 in D230)

Astrobiology

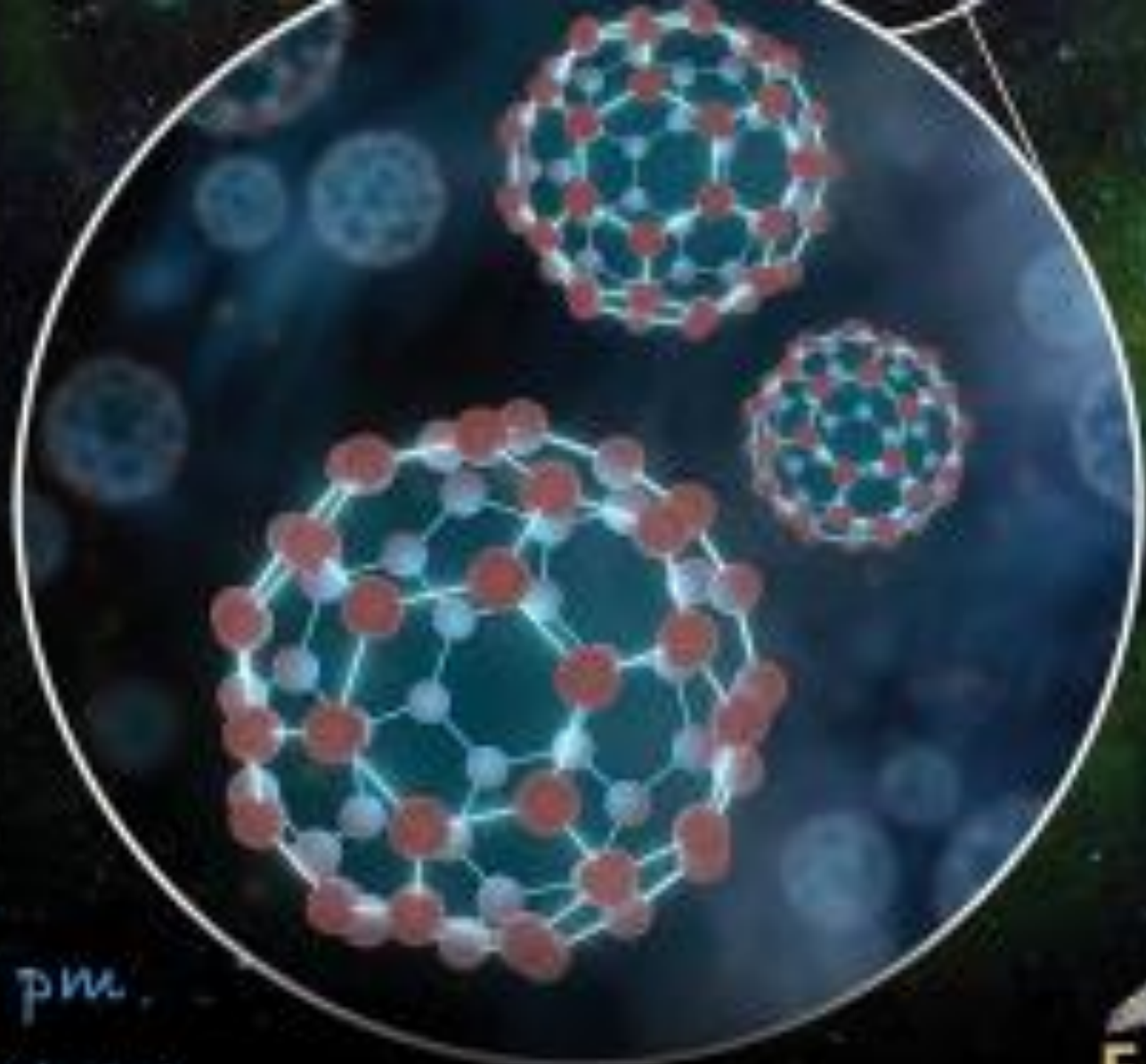
The Toolbox

in Search for Life

with

Vera Demchenko





7 pm

Oct 26

A talk in the CO Skies series

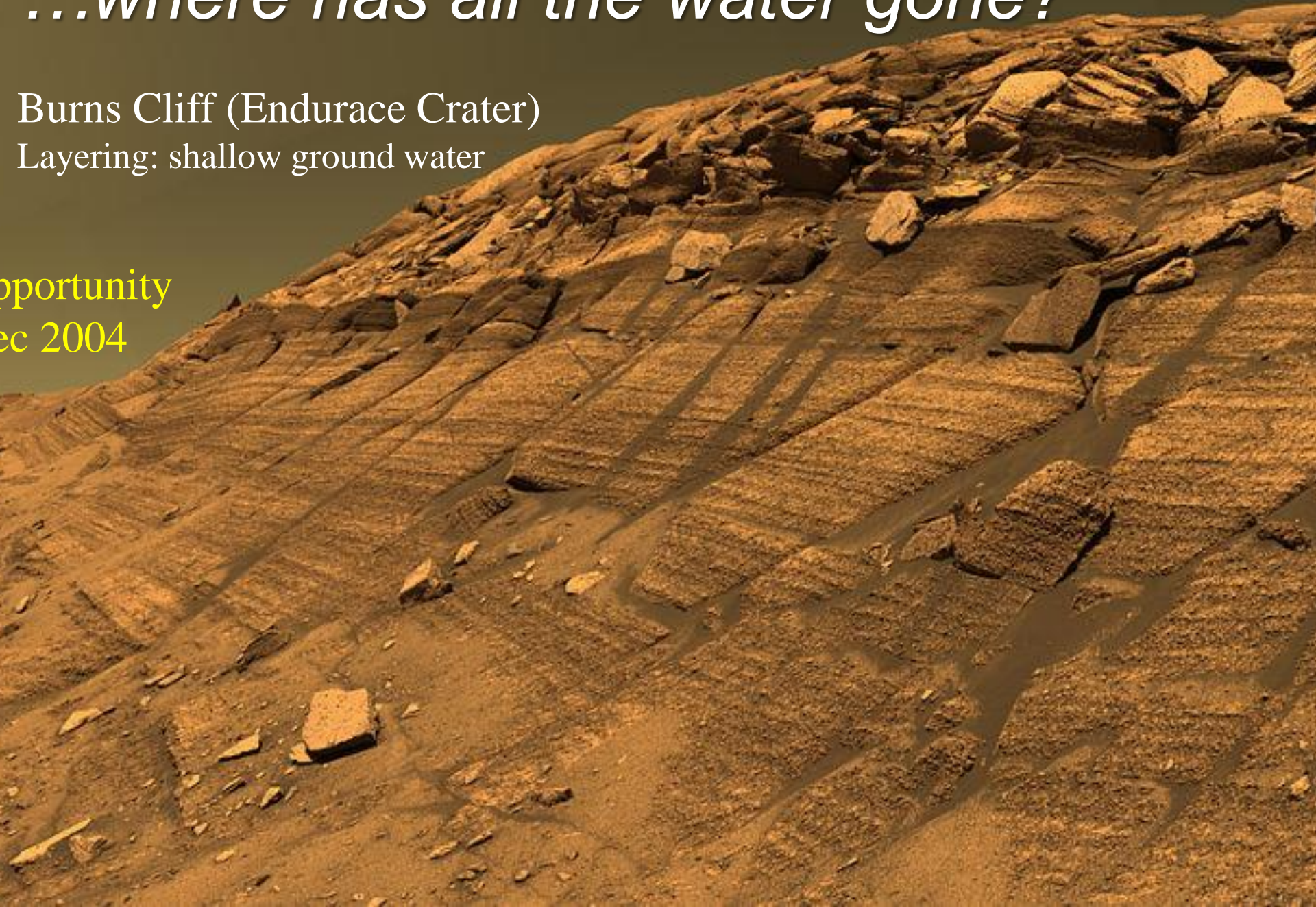


...where has all the water gone?

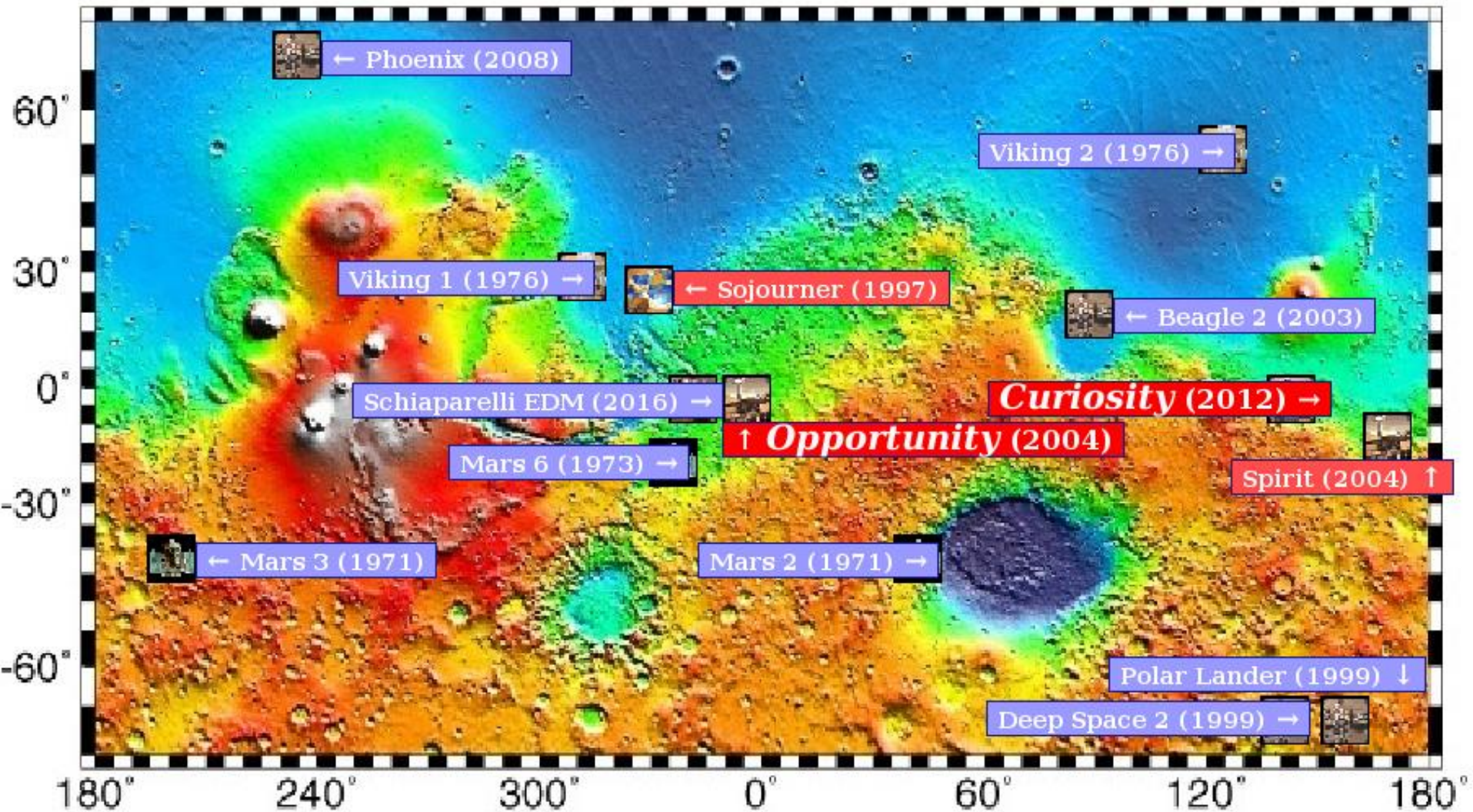
Burns Cliff (Endurance Crater)

Layering: shallow ground water

Opportunity
Dec 2004

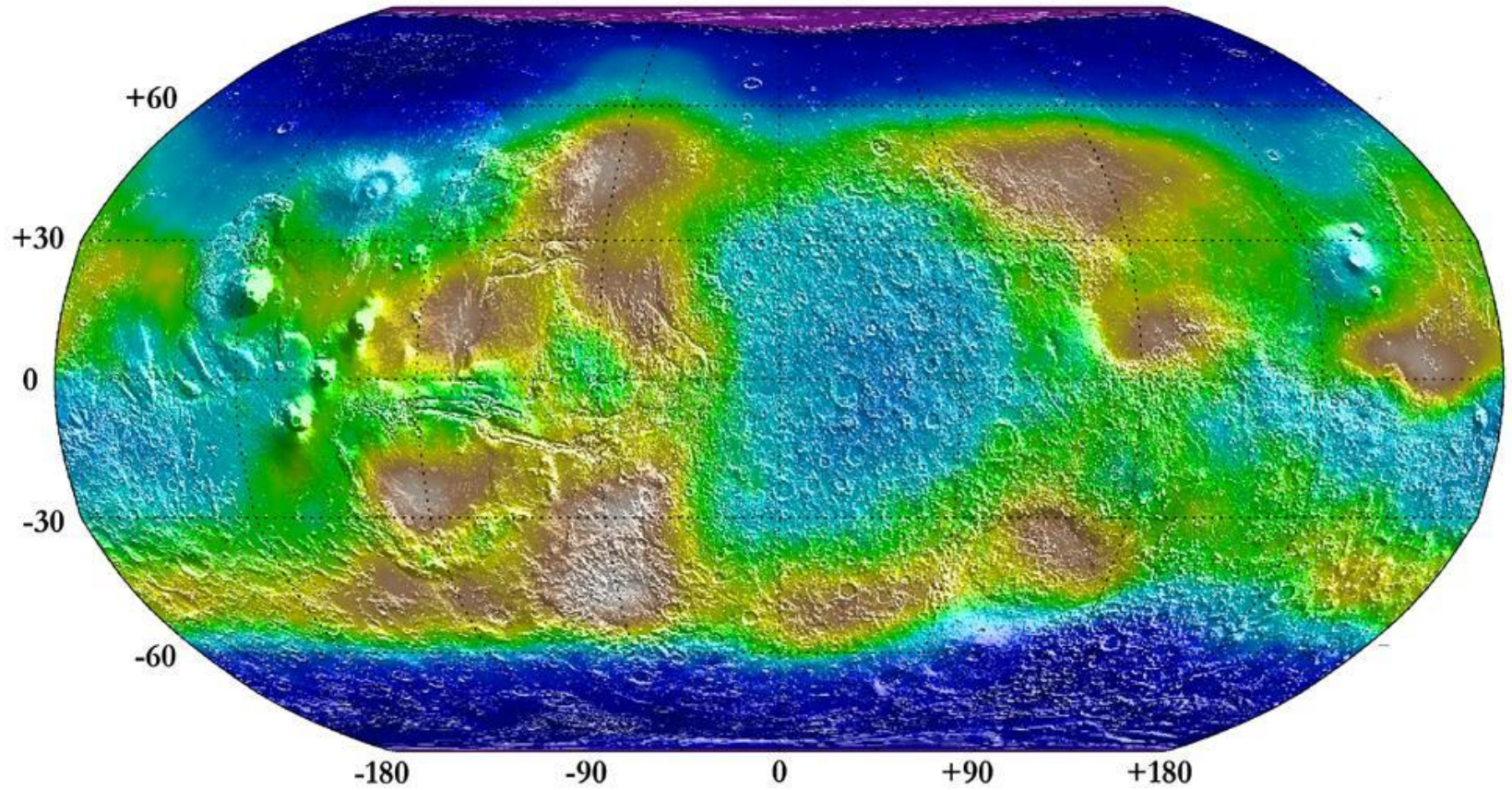
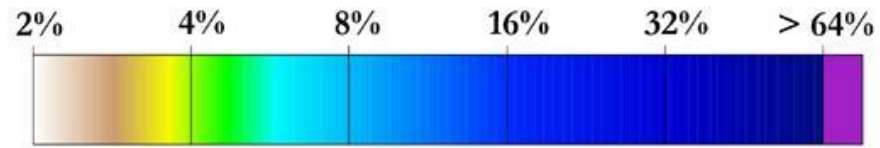


Modern topographic map of Mars



Opportunity: not even in a deep spot

Lower-Limit of Water Mass Fraction on Mars

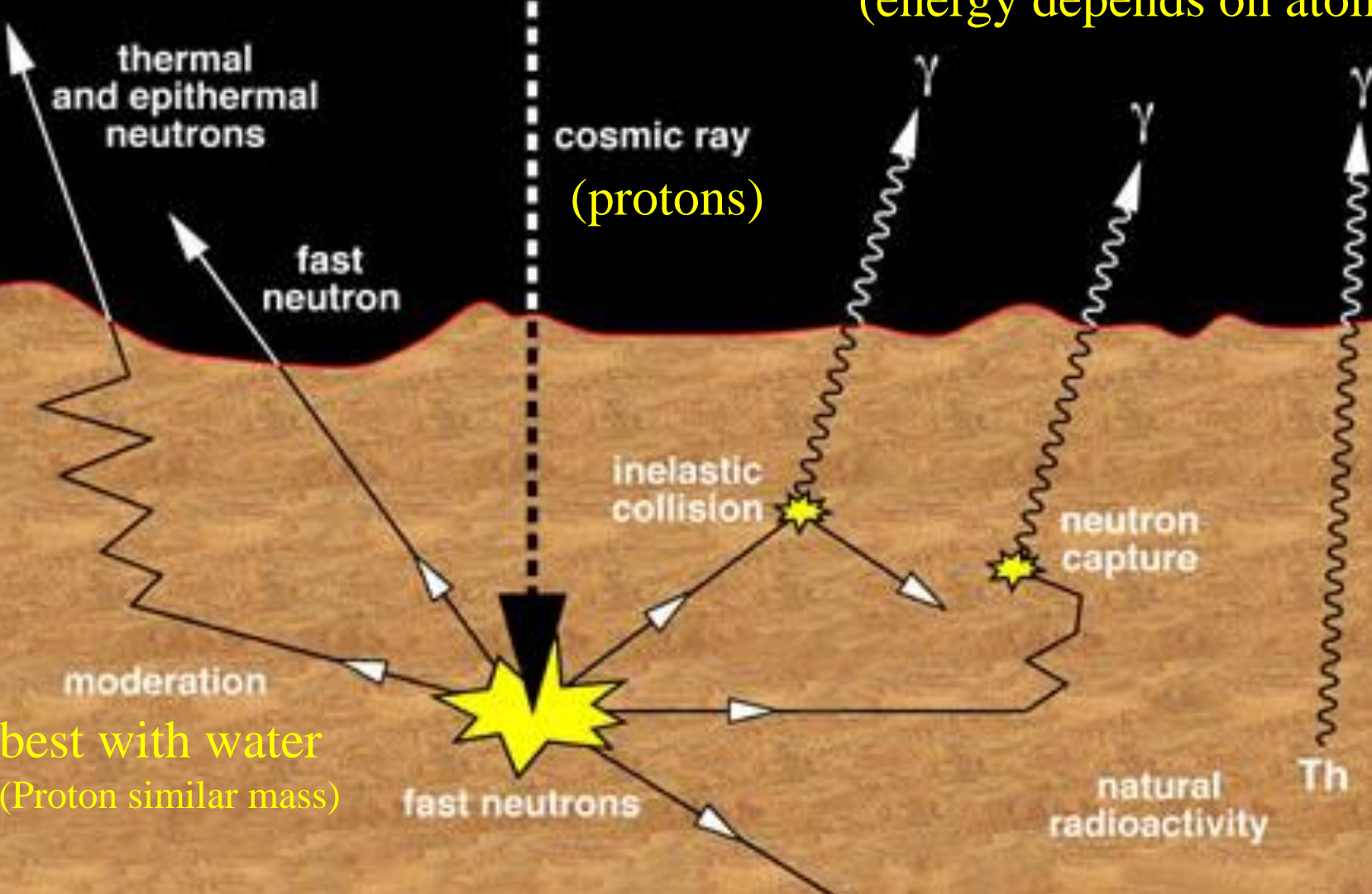


Detecting water from space

- Gamma ray spectrometer
 - Use "illumination" by cosmic rays
 - "fast" neutrons from collisions
 - Excite atoms → unique signature
- Observed hydrogen
 - Most of it is in H₂O

Nuclear Radiation from a Planetary Surface

(energy depends on atom)

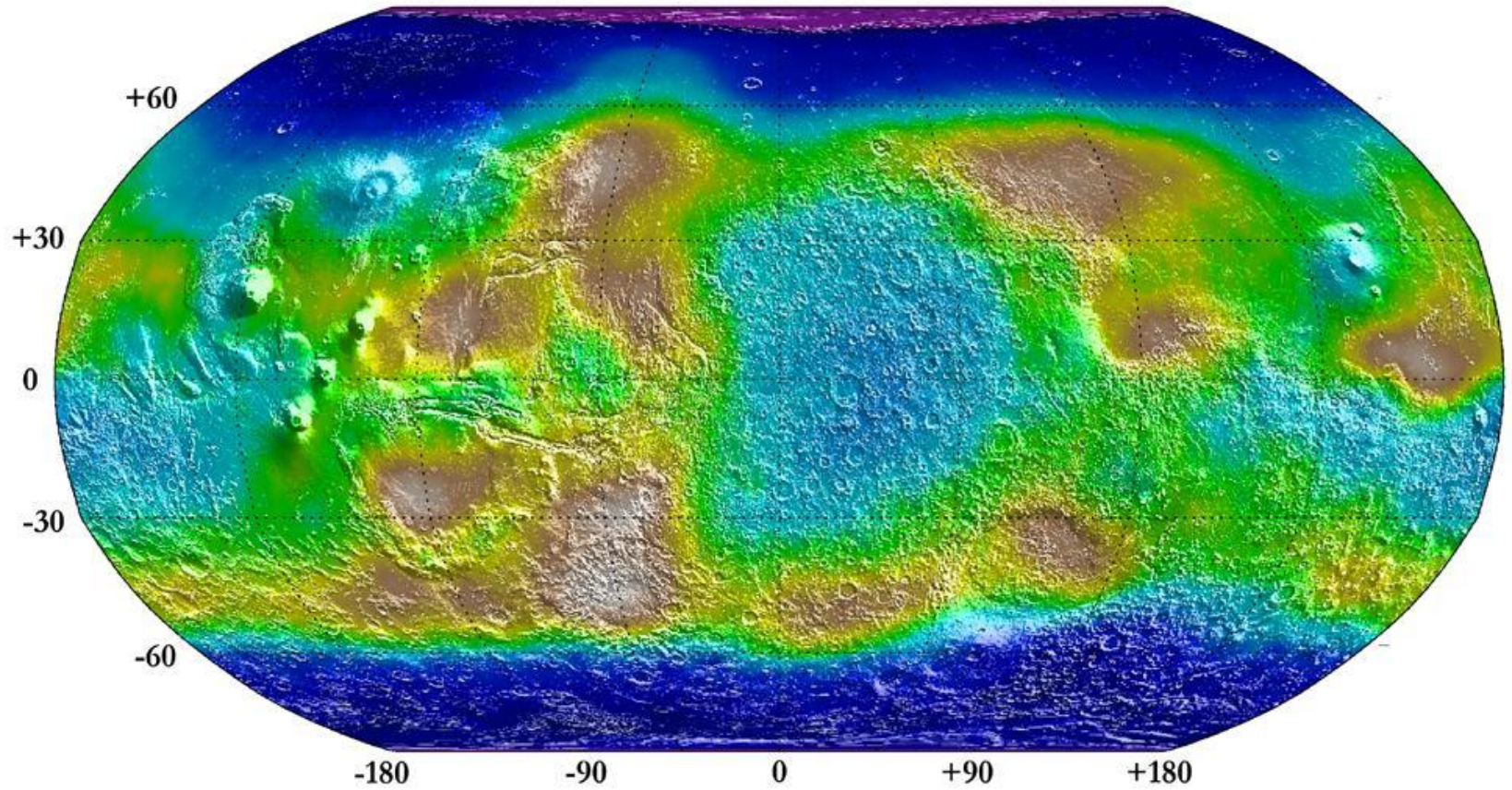
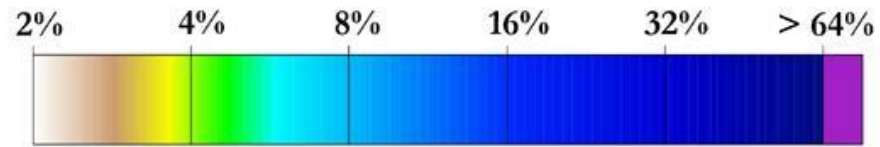


best with water
(Proton similar mass)

*Where is presently
most of the H₂O?*

- A. At high latitudes
- B. At mid latitudes
- C. Near the equator

Lower-Limit of Water Mass Fraction on Mars

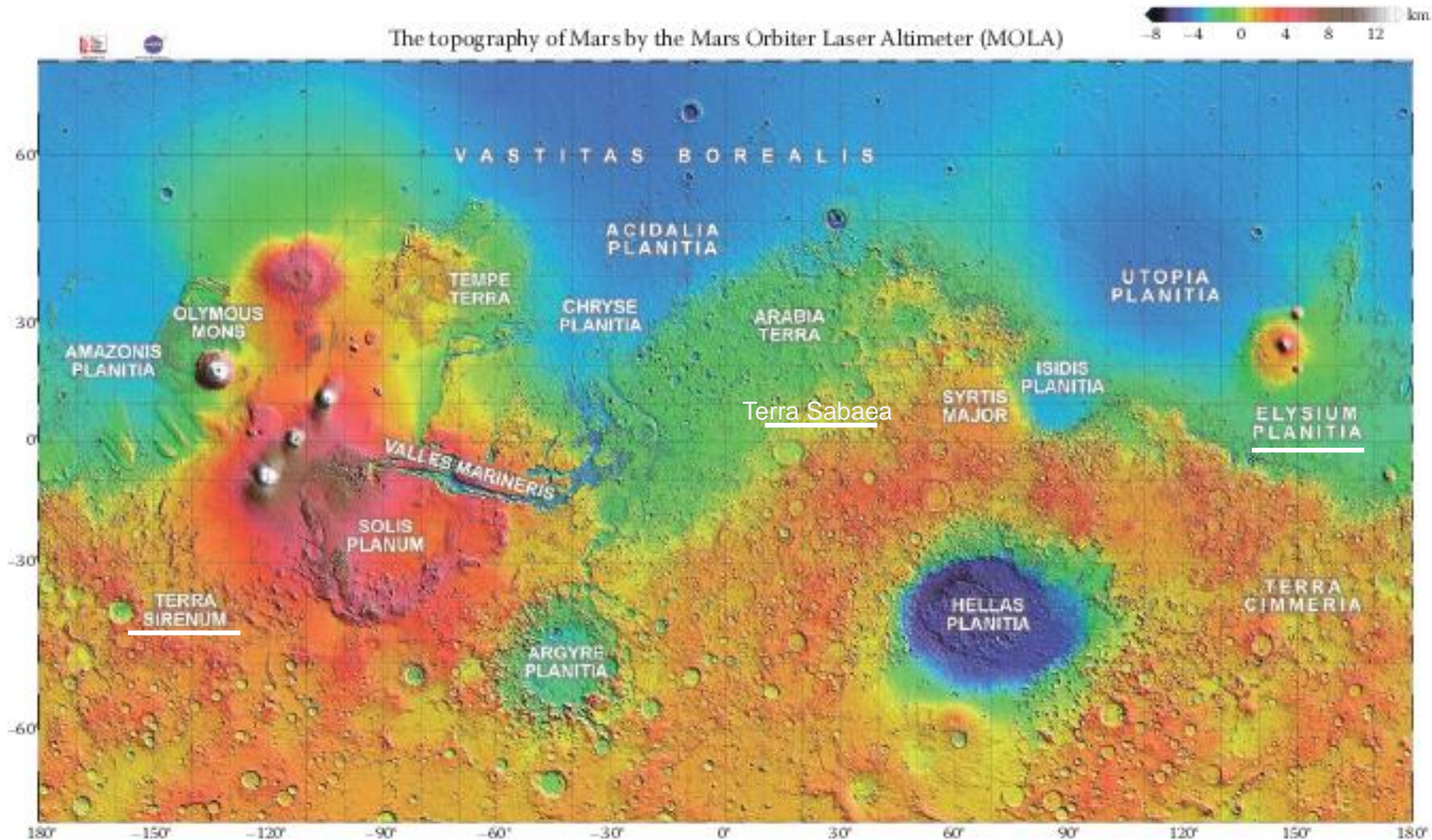


Where is most of the water?

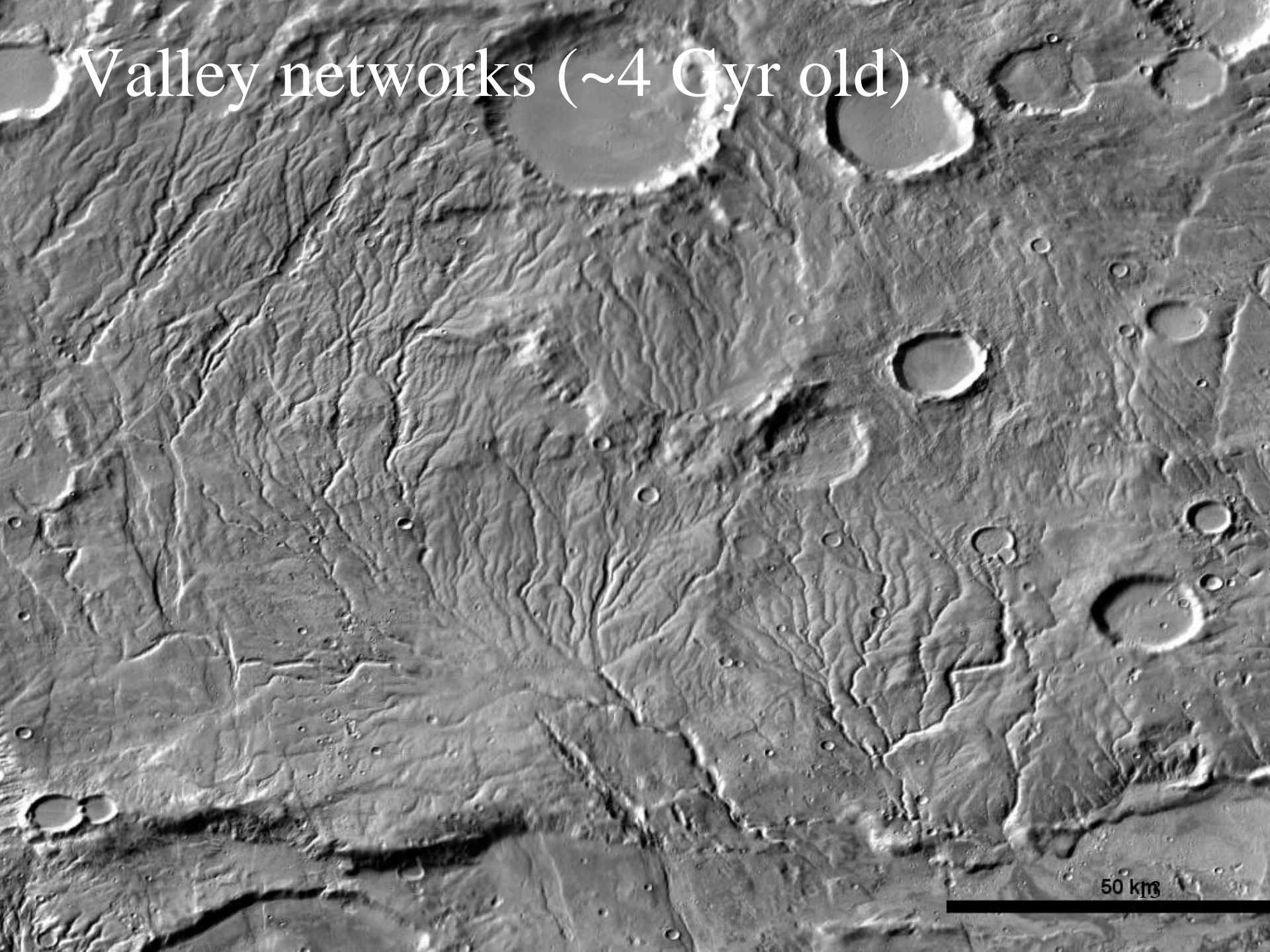
- A. At high latitudes
- B. At mid latitudes
- C. Near the equator

Low latitude H_2O patches

Elysium, Terra Sabaea, Terra Sirenum (proximity to volcanoes: increased melt)

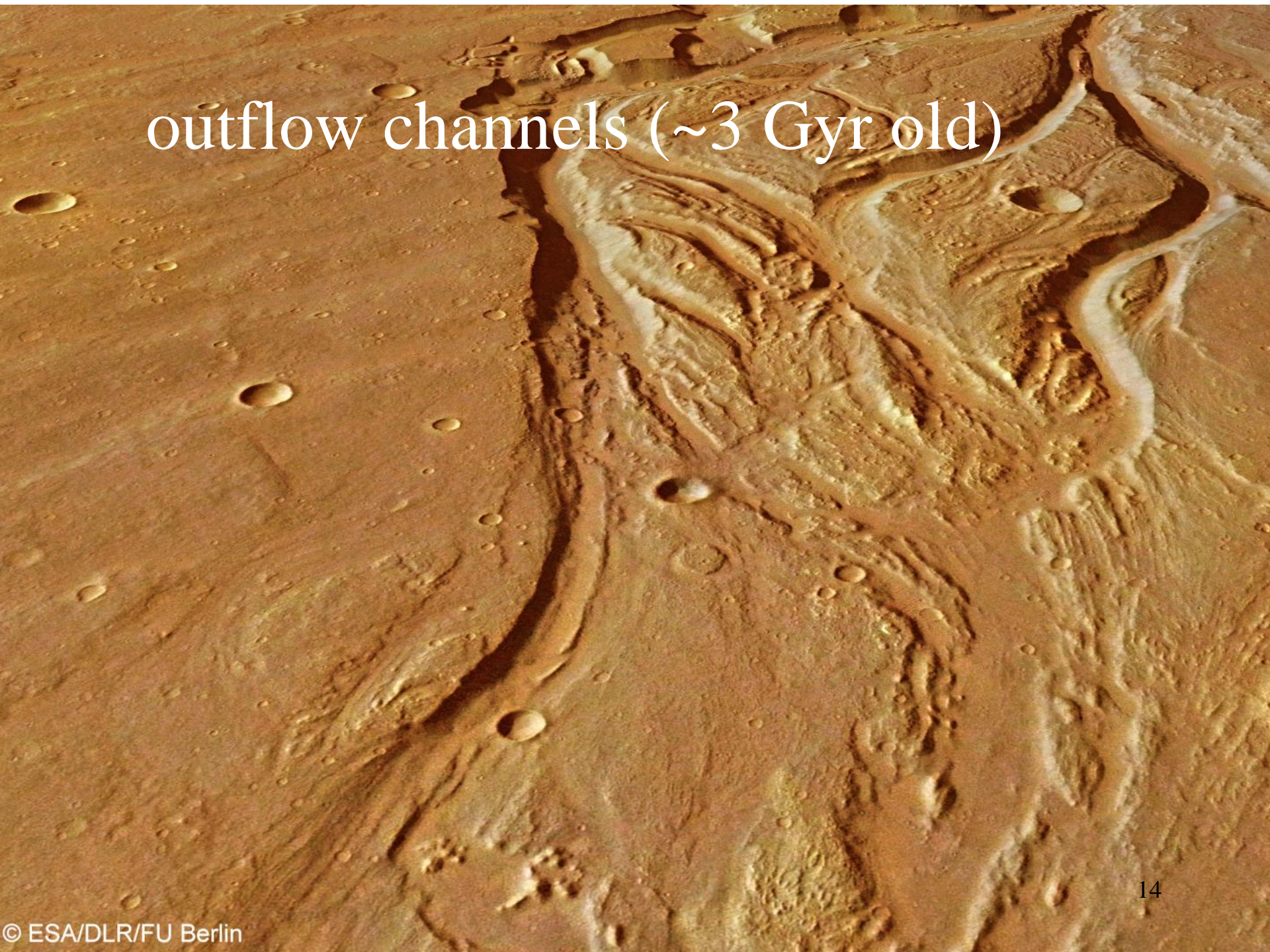


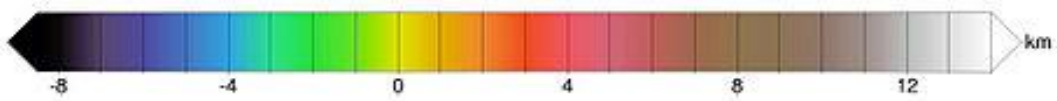
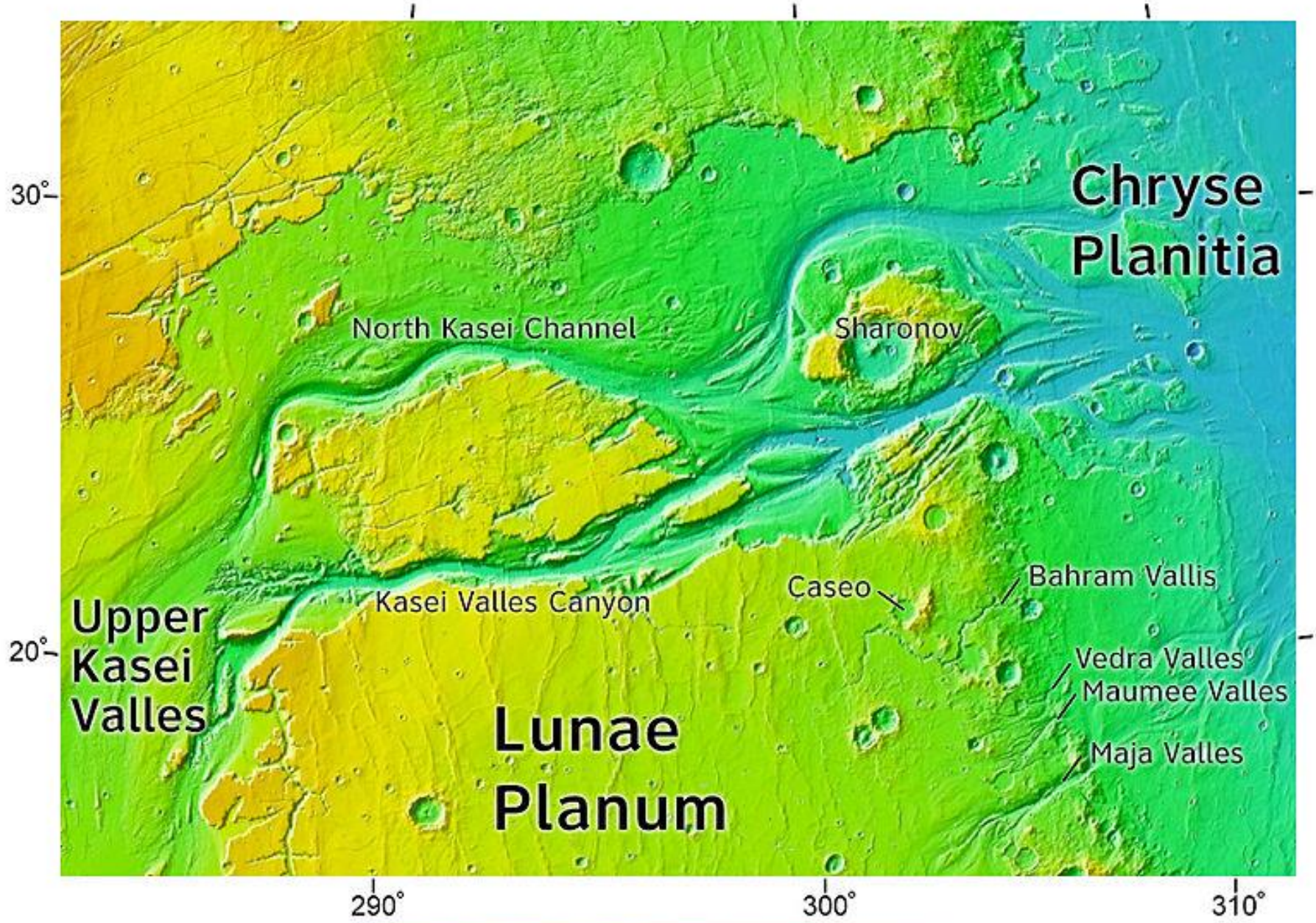
Valley networks (~4 Gyr old)



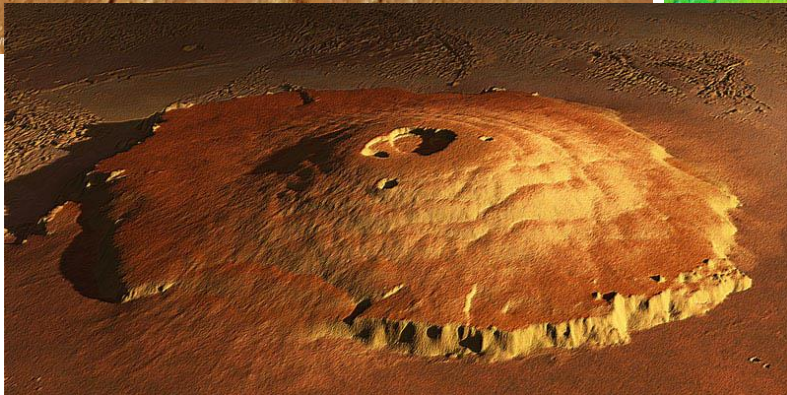
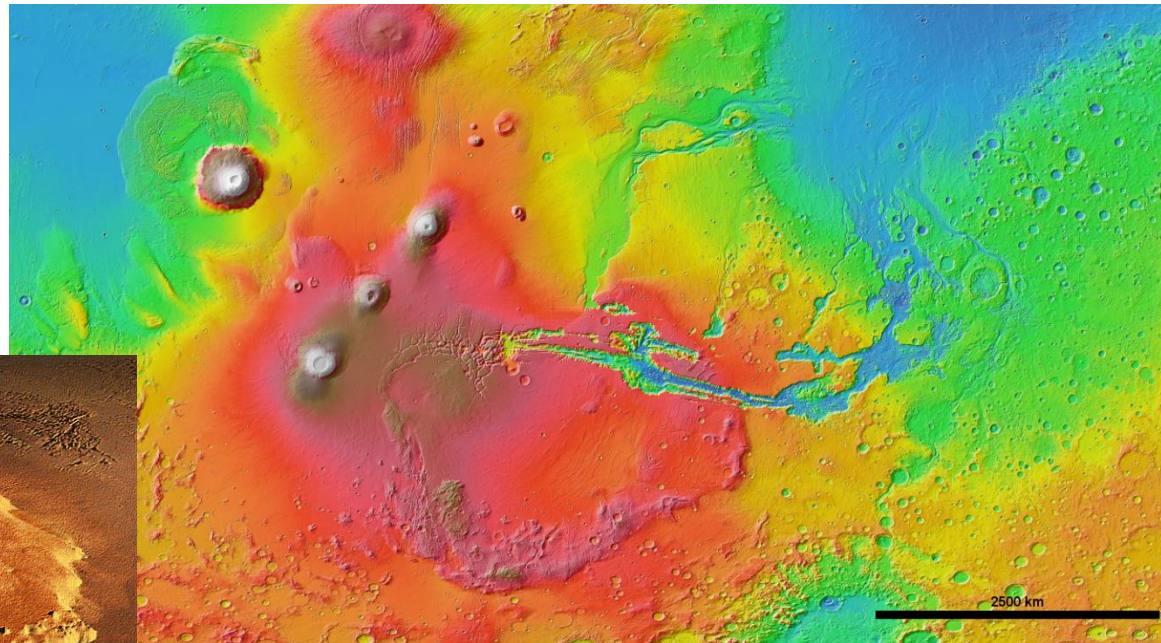
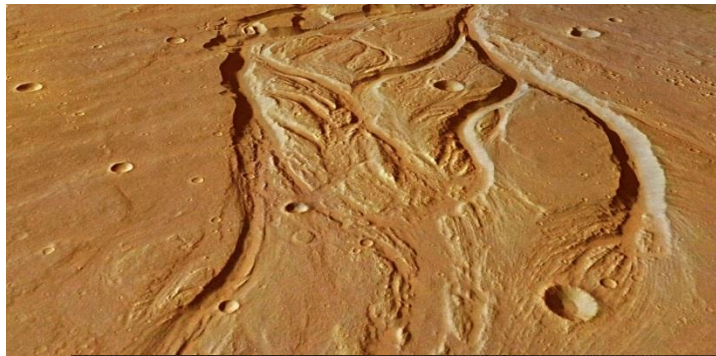
50 km

outflow channels (~3 Gyr old)





outflow channels are mainly associated with...



Volcanoes!

- Massive events clearly associated with volcanic

So what does γ ray spectrometer observe?

A. γ rays

B. fast neutrons

C. thermal (slow) neutrons

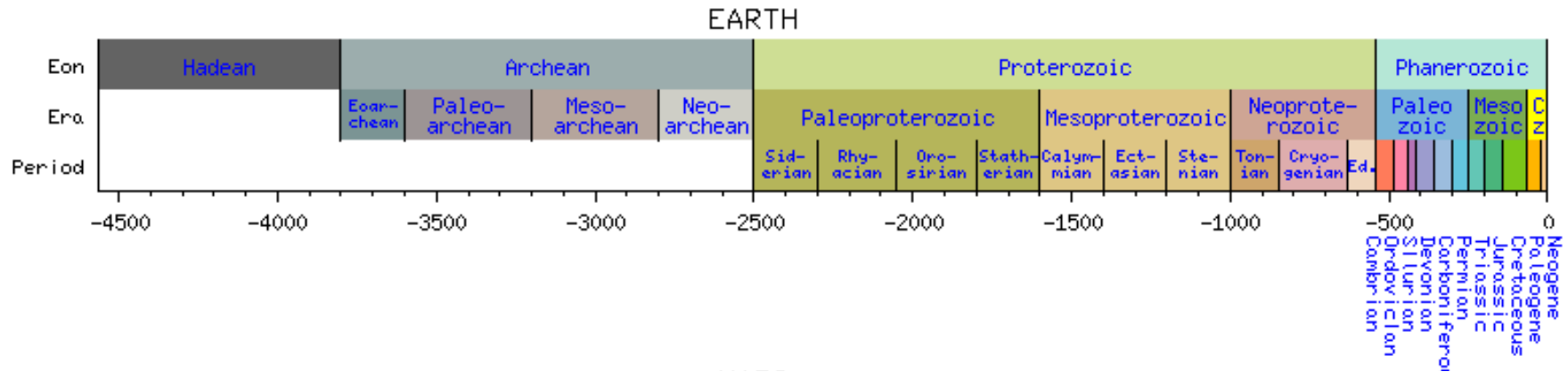
So what does γ ray spectrometer observe?

A. γ rays

B. fast neutrons

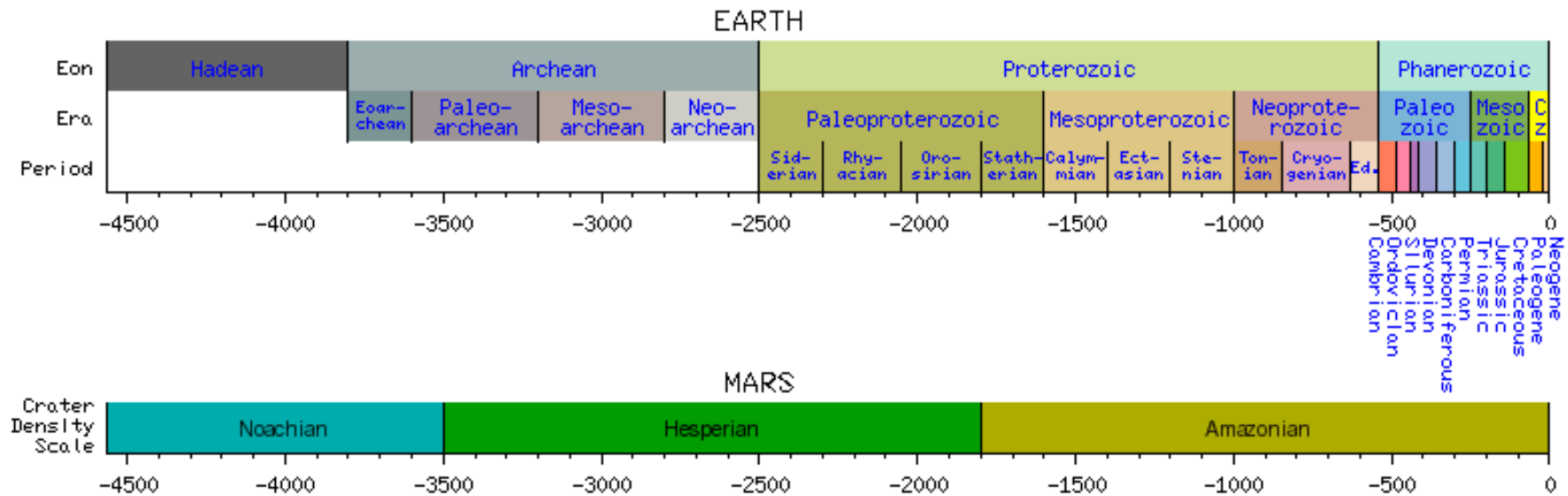
C. thermal (slow) neutrons

Eons on Earth



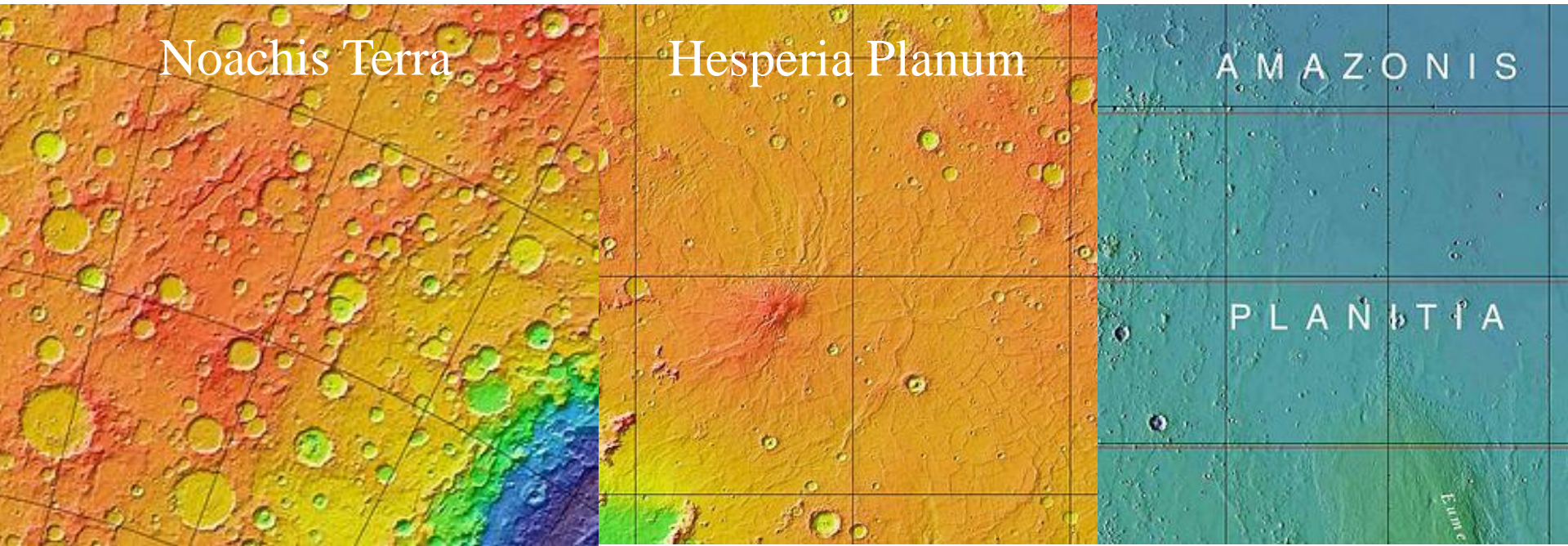
- Hadean (3.8 – 4.6 Gyr)
- Archean (2.5 – 3.8 Gyr)
- Proterozoic (0.55 – 2.5 Gyr)
- Phanerozoic

Different eons for Martians



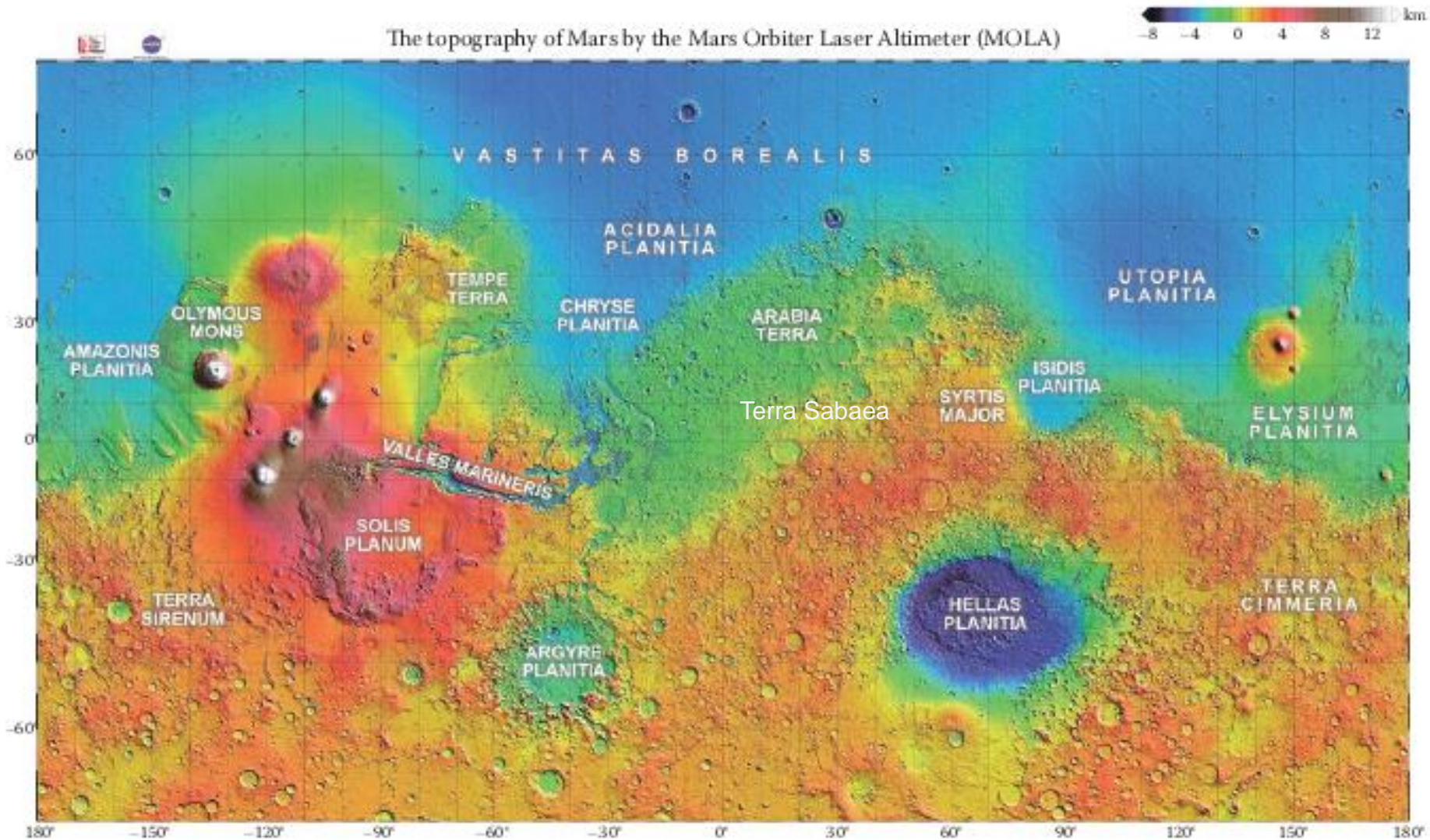
- Noachian (3.7 – 4.1 Gyr, warm & wet)
- Hesperian (3 – 3.7 Gyr, volcanoes, acidic)
- Amazonian (0 – 3 Gyr, cold, hyperarid)

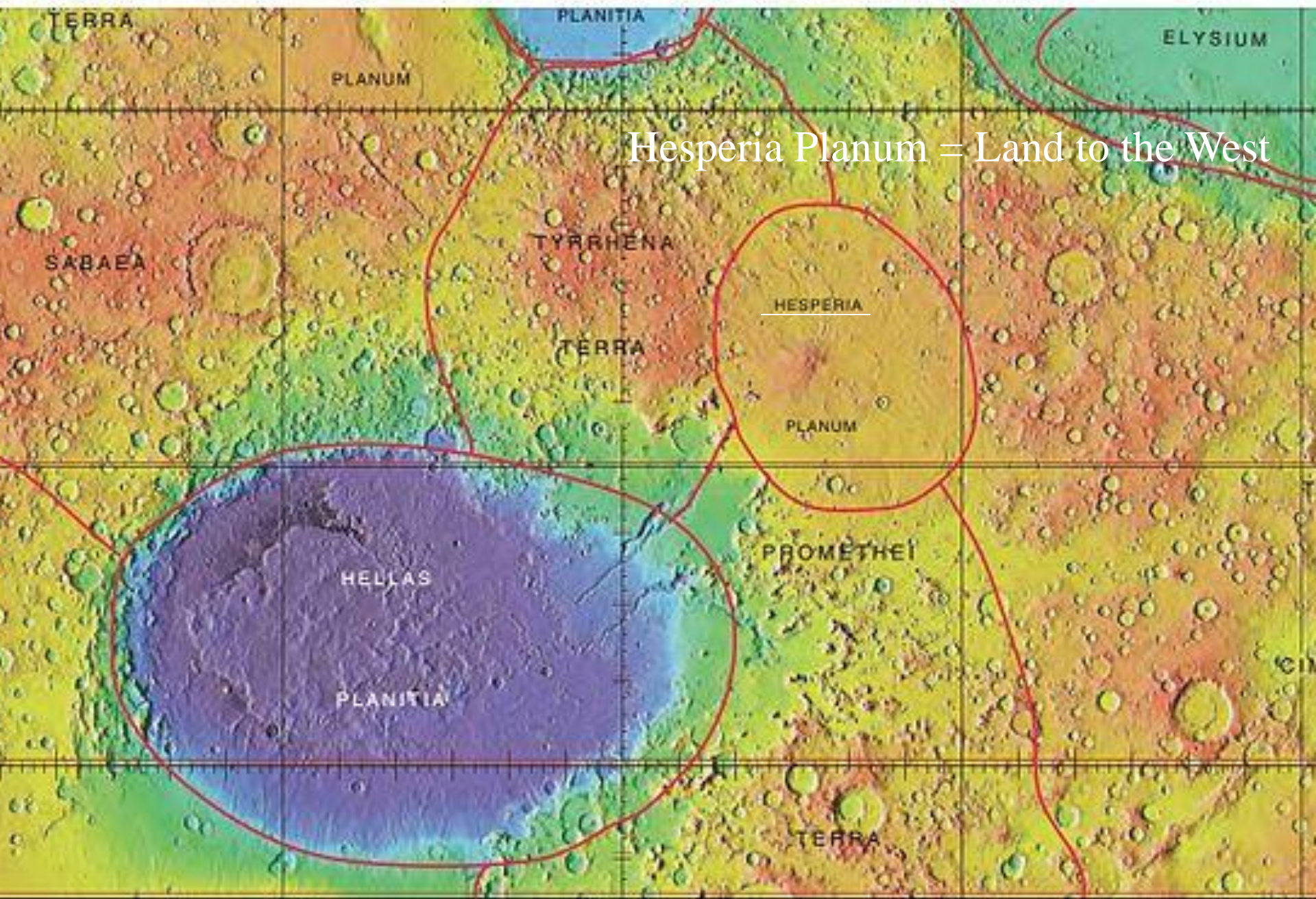
What's different btw the 3



- A. Craters
- B. Volcanos
- C. Elevation
- D. Latitude

Amazonis Planitia





Hesperia Planum = Land to the West

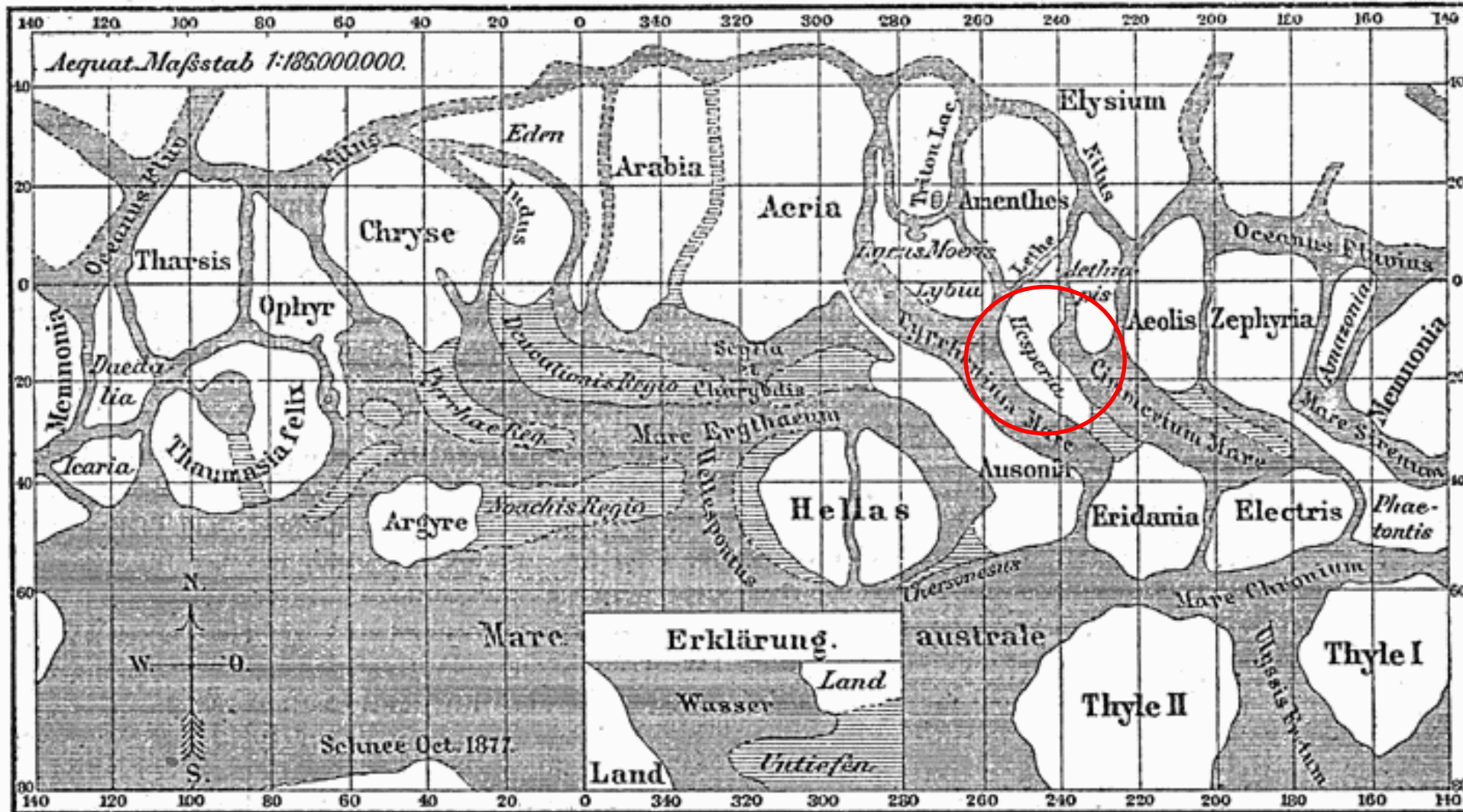
300° W

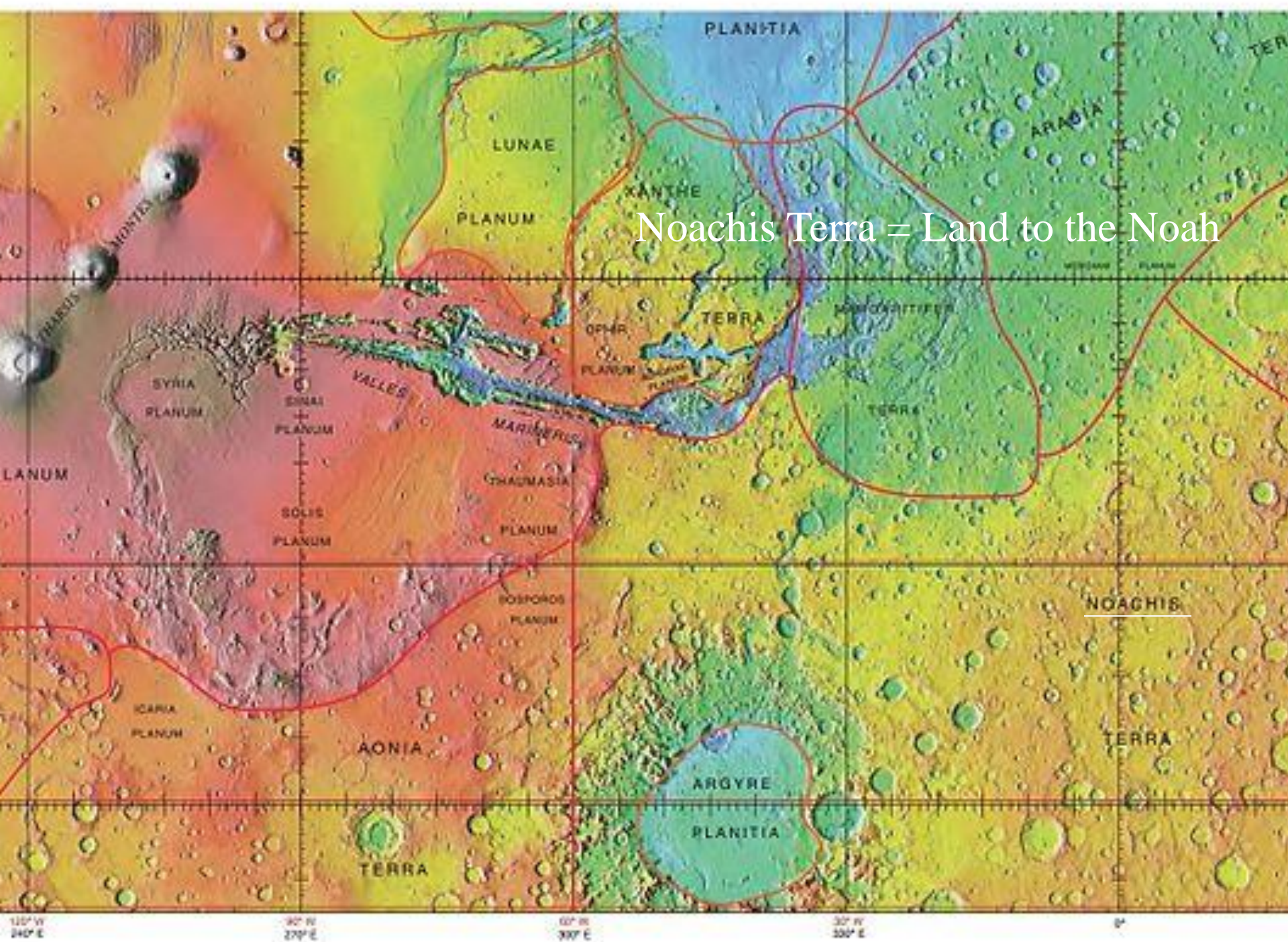
270° W

240° W

210° W

Schiaparelli (1899)

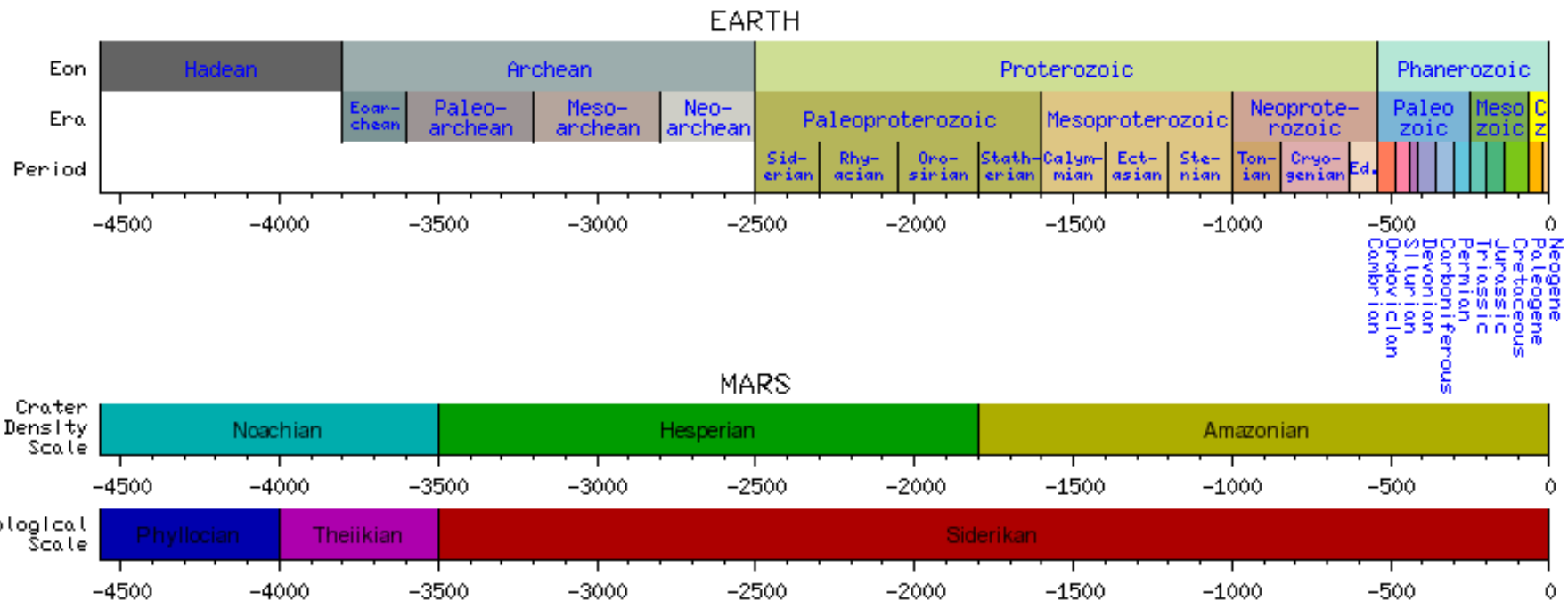




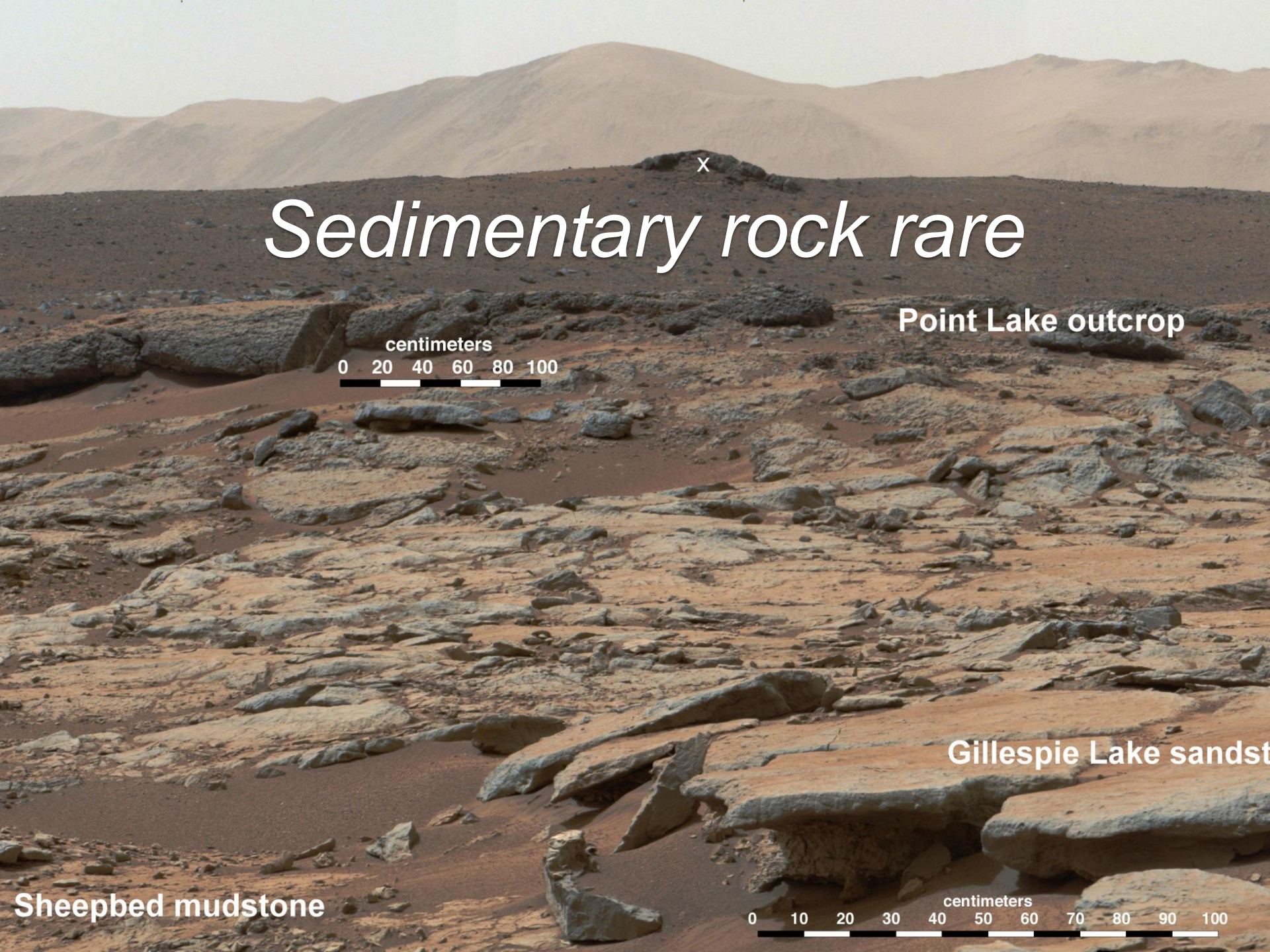
Noachis Terra = Land to the Noah

110° W 240° E 90° W 270° E 60° W 300° E 30° W 330° E 0°

There can be different ones



- Phyllocias = phyllosilicates
- Theriikian = sulphurous
- Siderikan = iron



x

Sedimentary rock rare

Point Lake outcrop

centimeters
0 20 40 60 80 100

Gillespie Lake sandst

Sheepbed mudstone

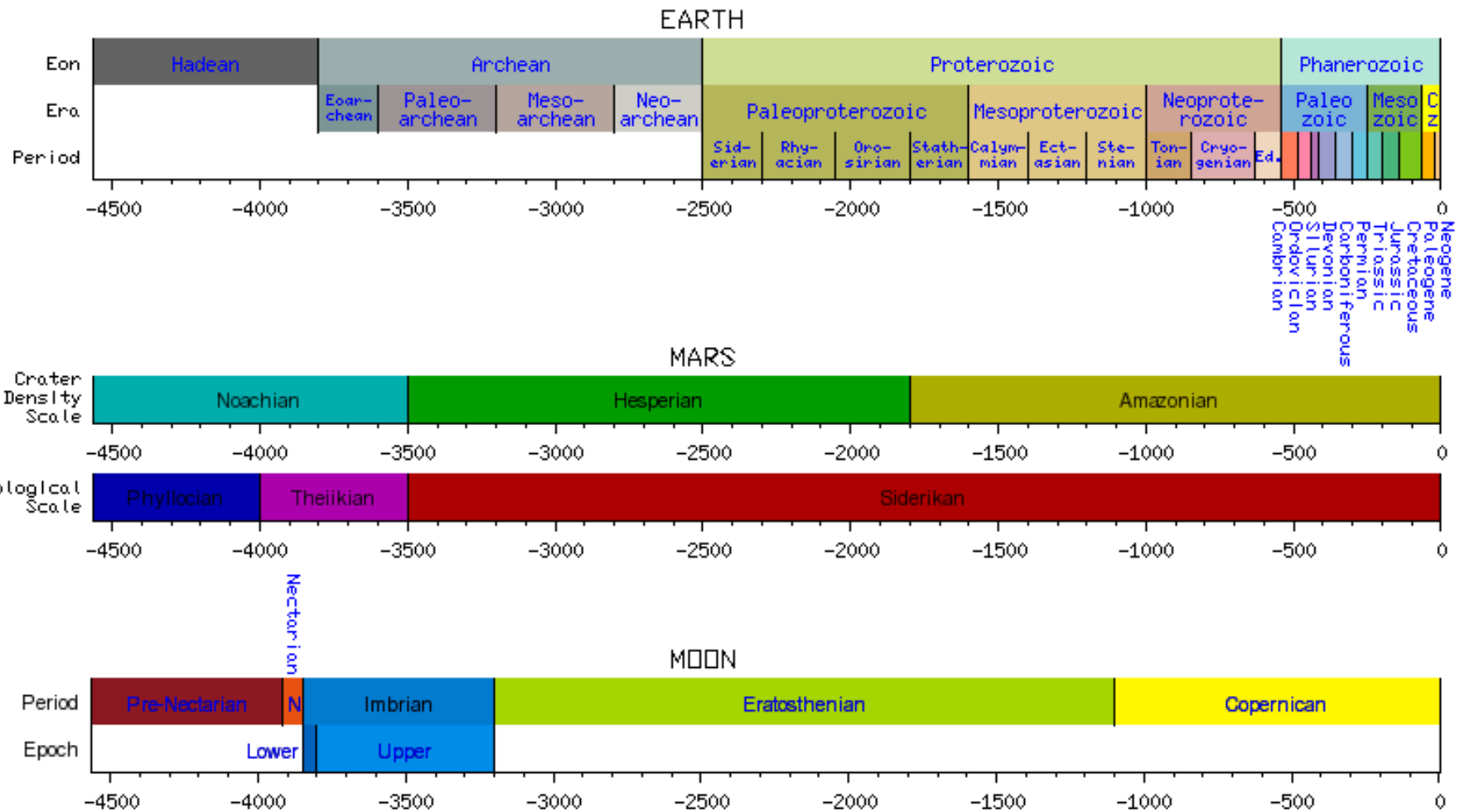
centimeters
0 10 20 30 40 50 60 70 80 90 100

Carbonates rare: 2 – 5 wt%

- wt% = percentage by weight
 - Evidence of wet & warm past
- Why only 2 – 5 wt% ?
 - Earth: 10% of sedimentary rocks are limestone
 - Mars: no time to form?
 - No: became acidic 3 Gyr ago (sulfate-rich)



They got the idea from the Moon



Monday

- Atmospheric escape
- Methane
- Meteorites
 - RGS pp. 109 – 119