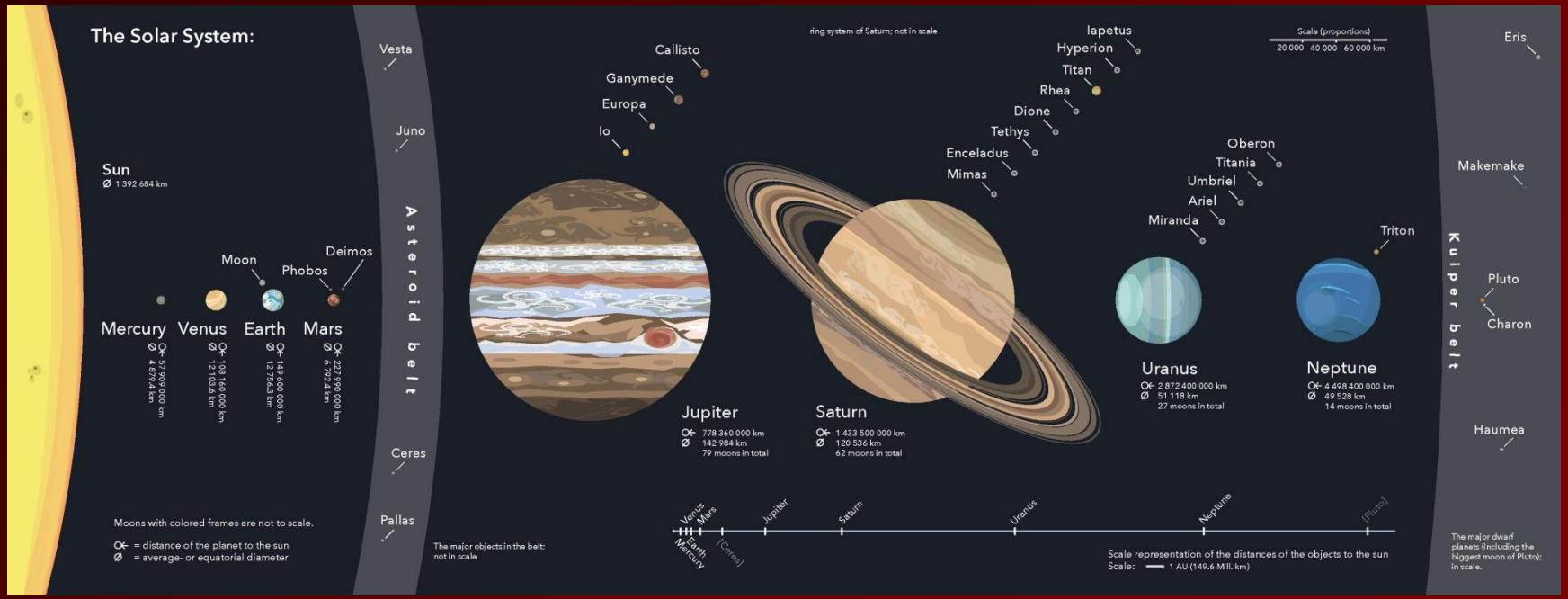
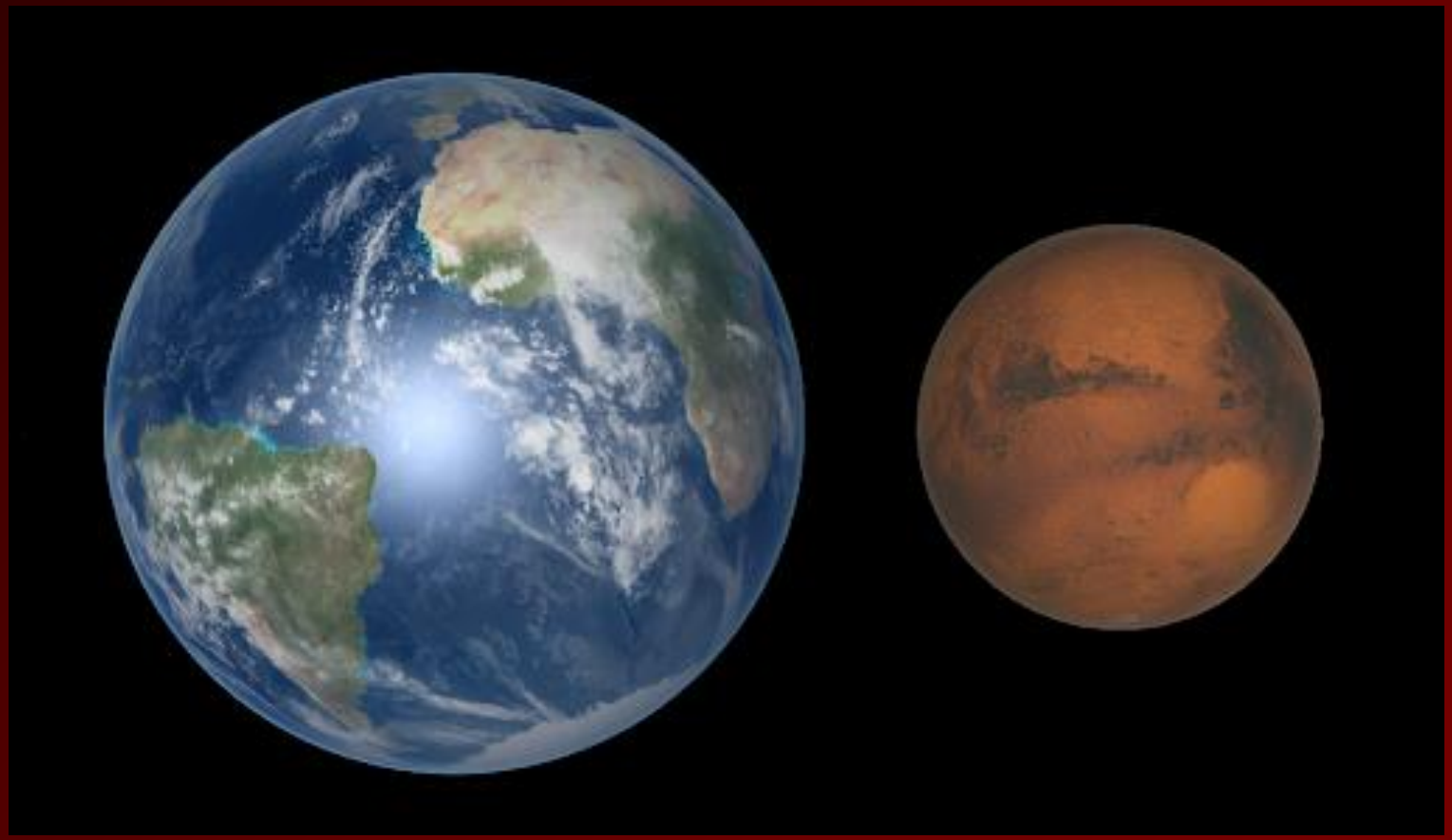
Mars

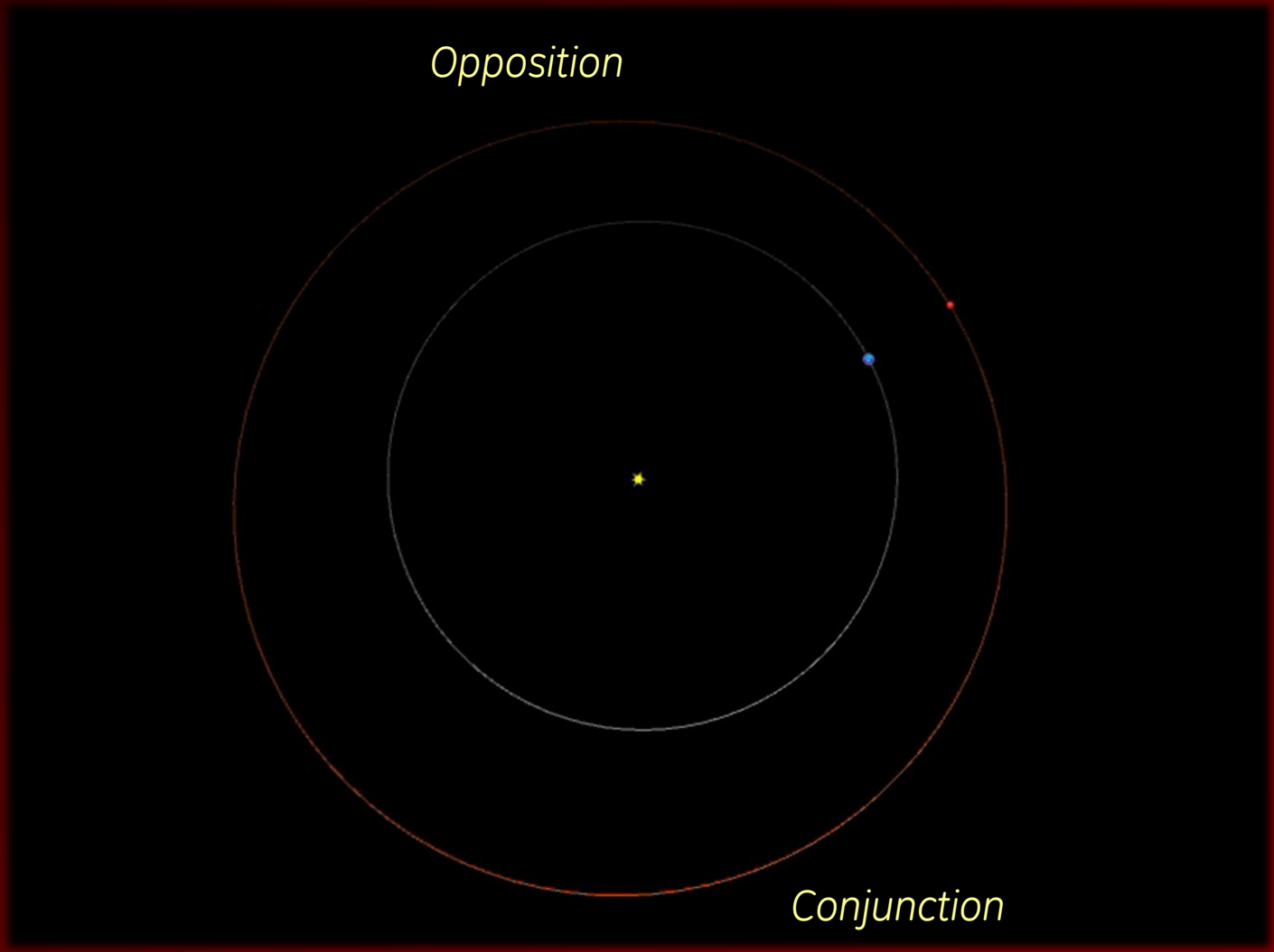
Fourth Planet from the Sun



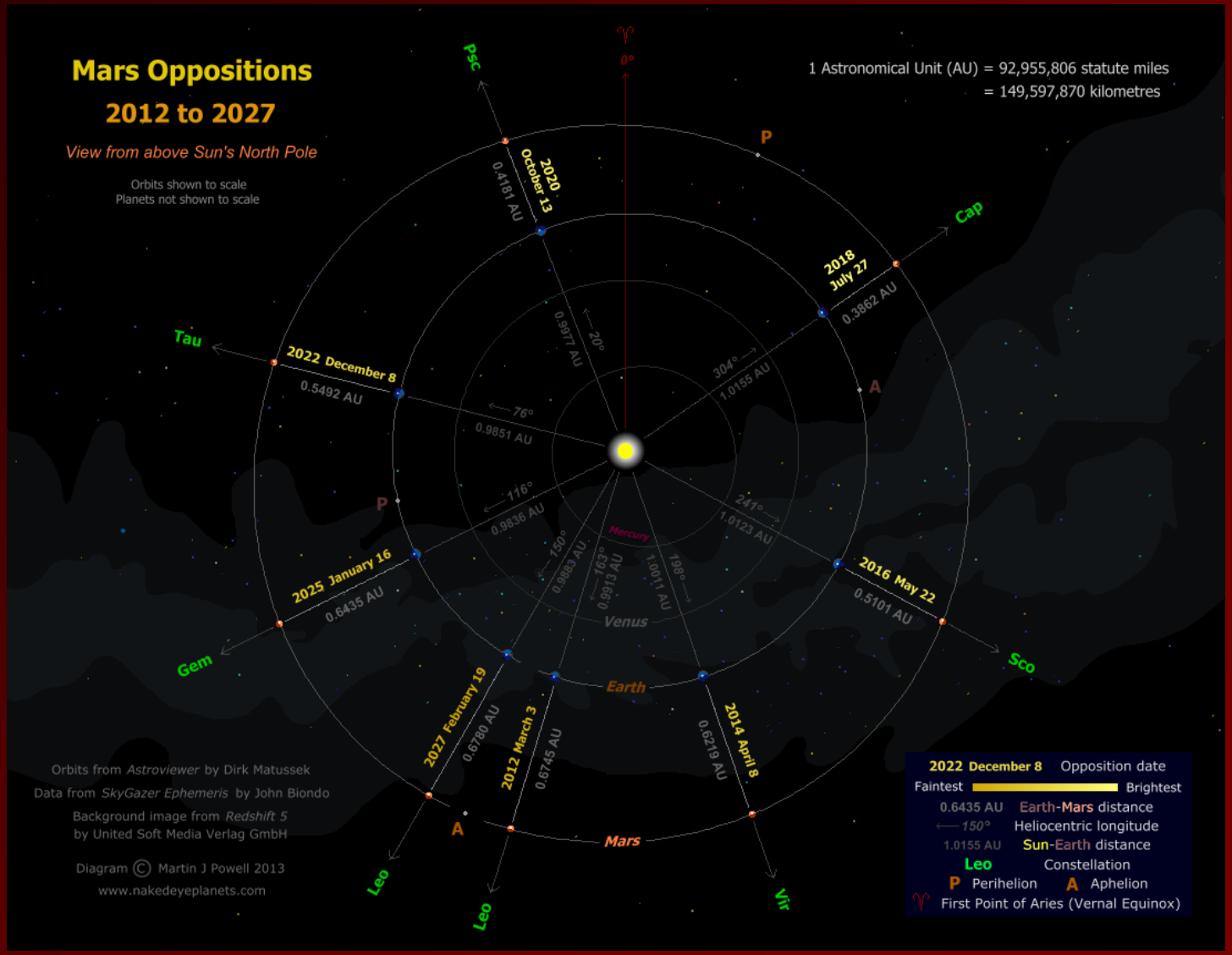
Just a Little Guy



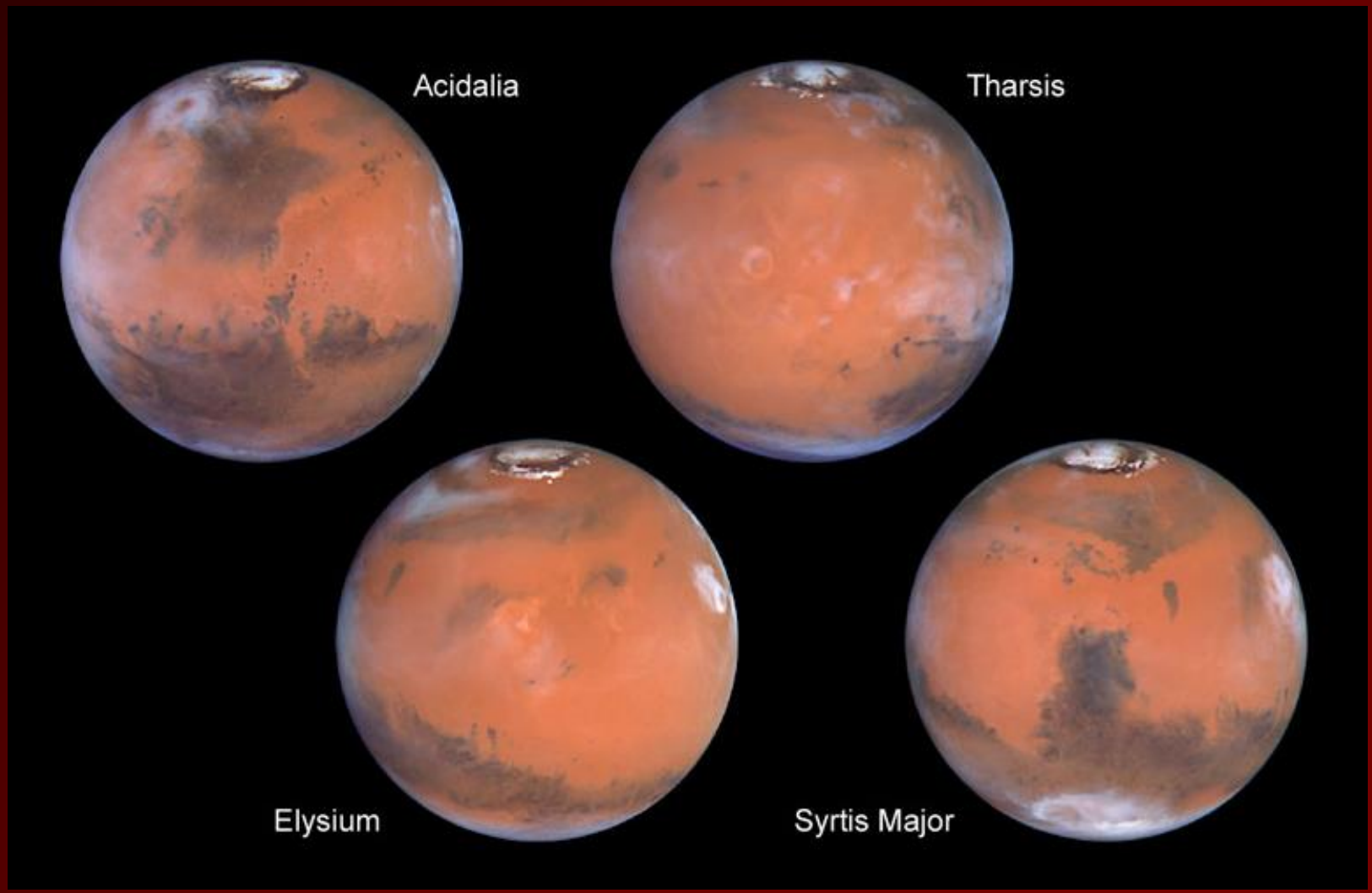
How Far Away Is Mars?



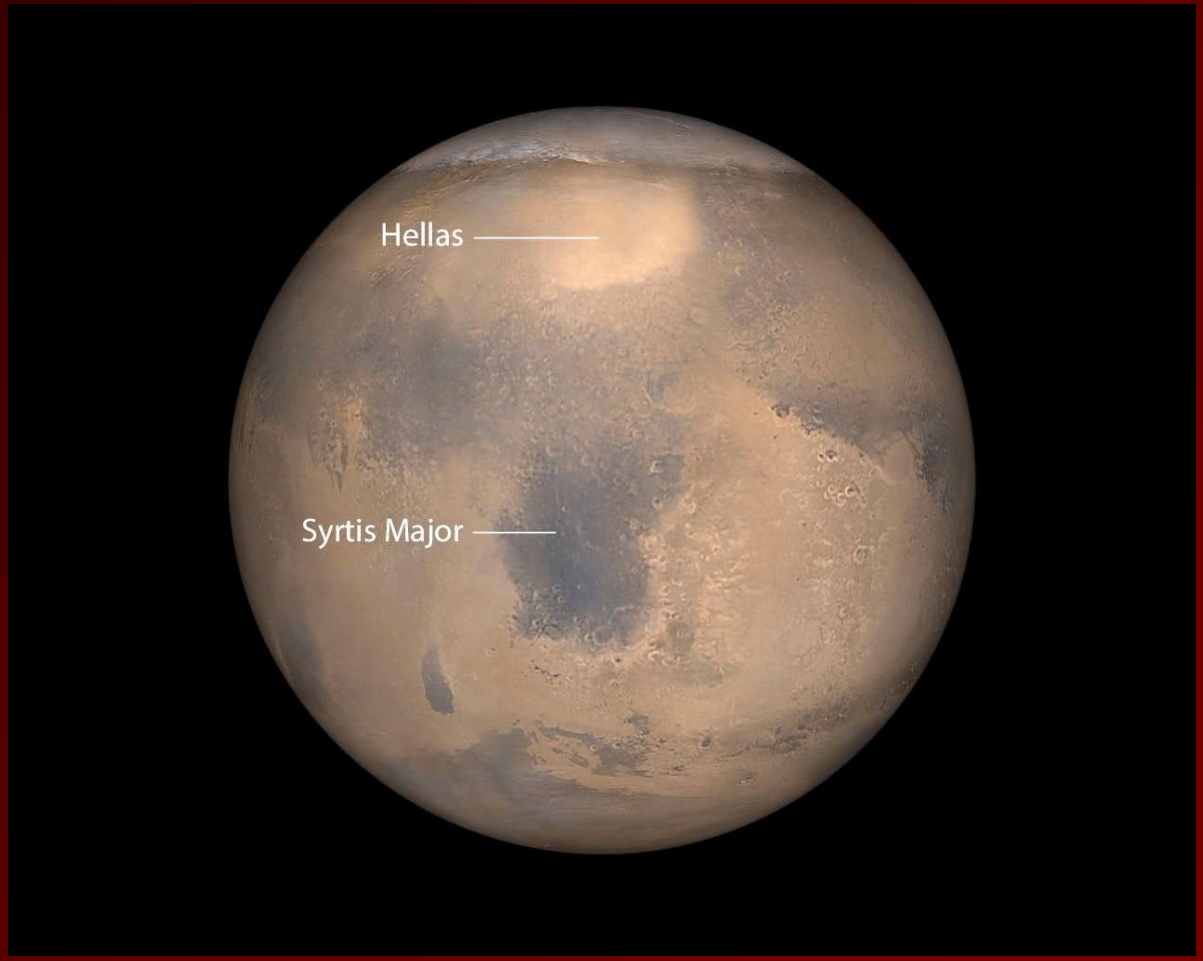
Especially Good Time to See Mars



Key Martian Landmarks



Syrtis Major & Hellas

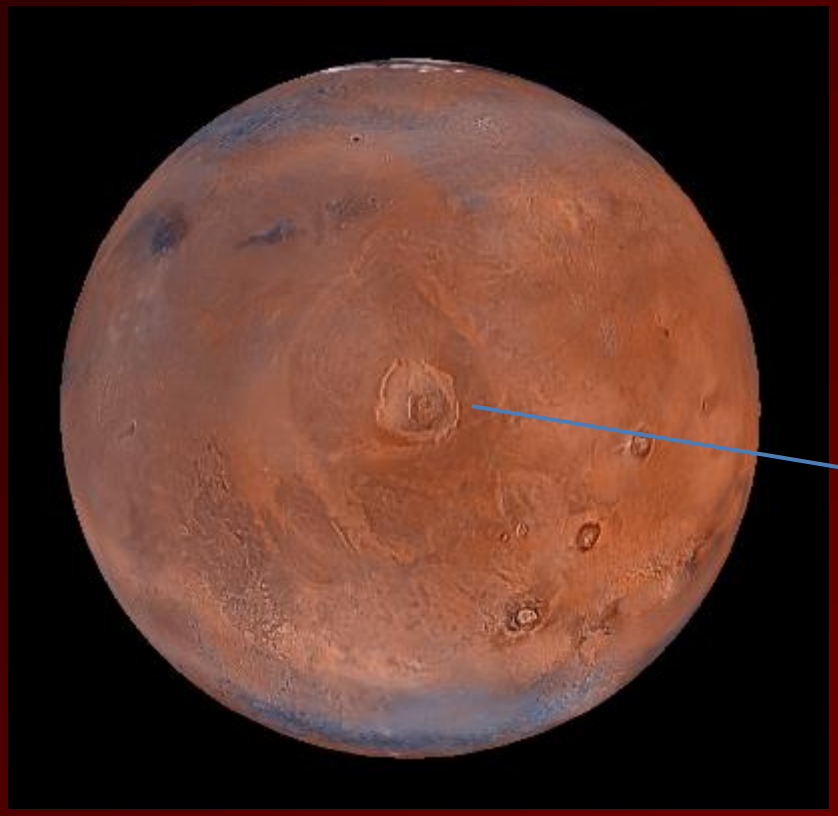


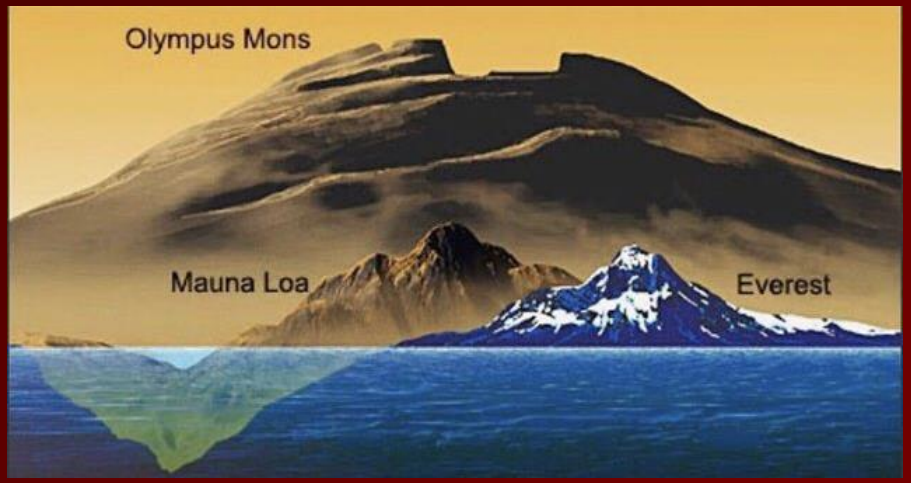
South is Up

Schiaparelli Crater

Sketch by Giovanni Schiaparelli

The Volcanoes

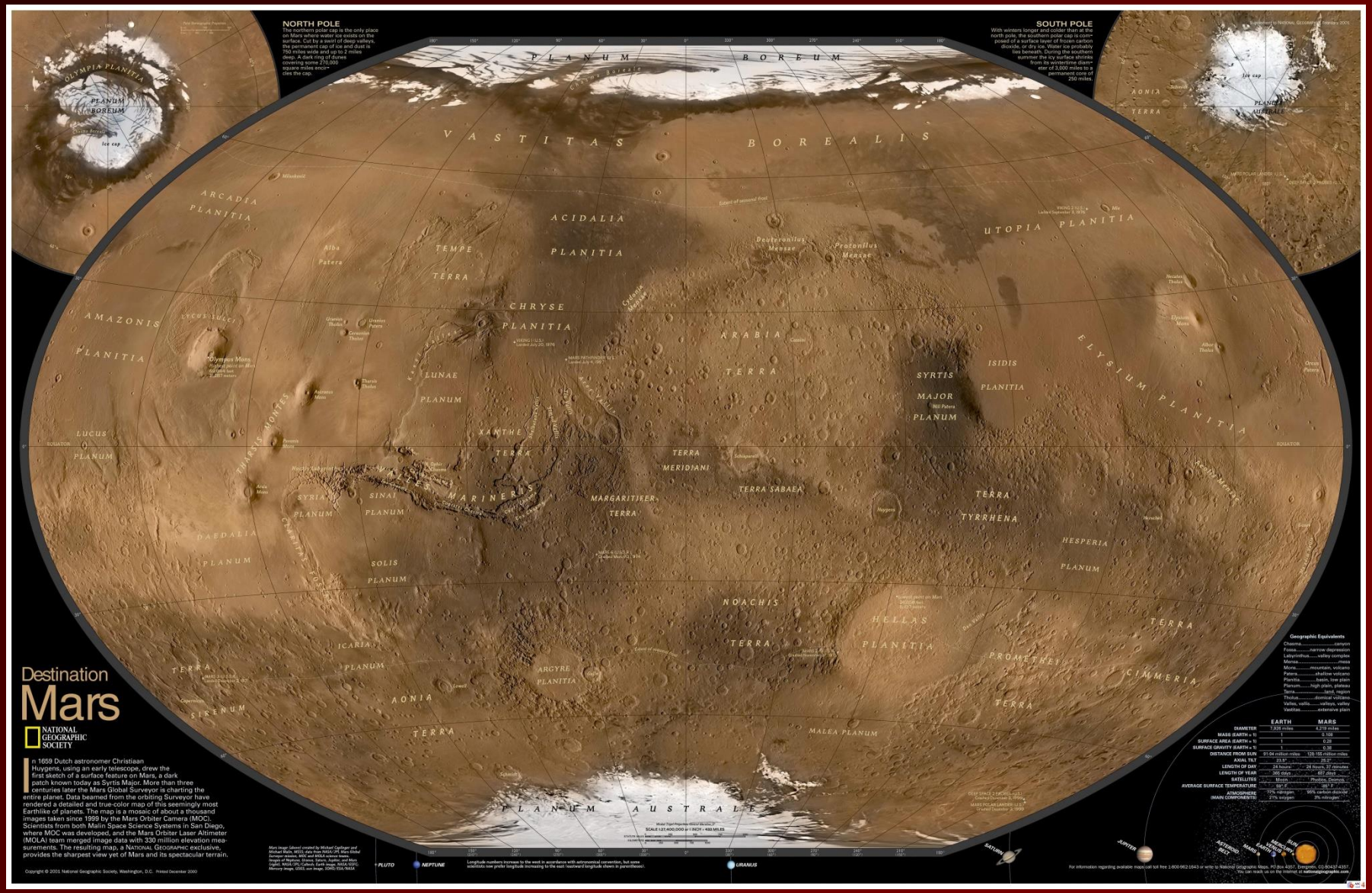




Olympus Mons

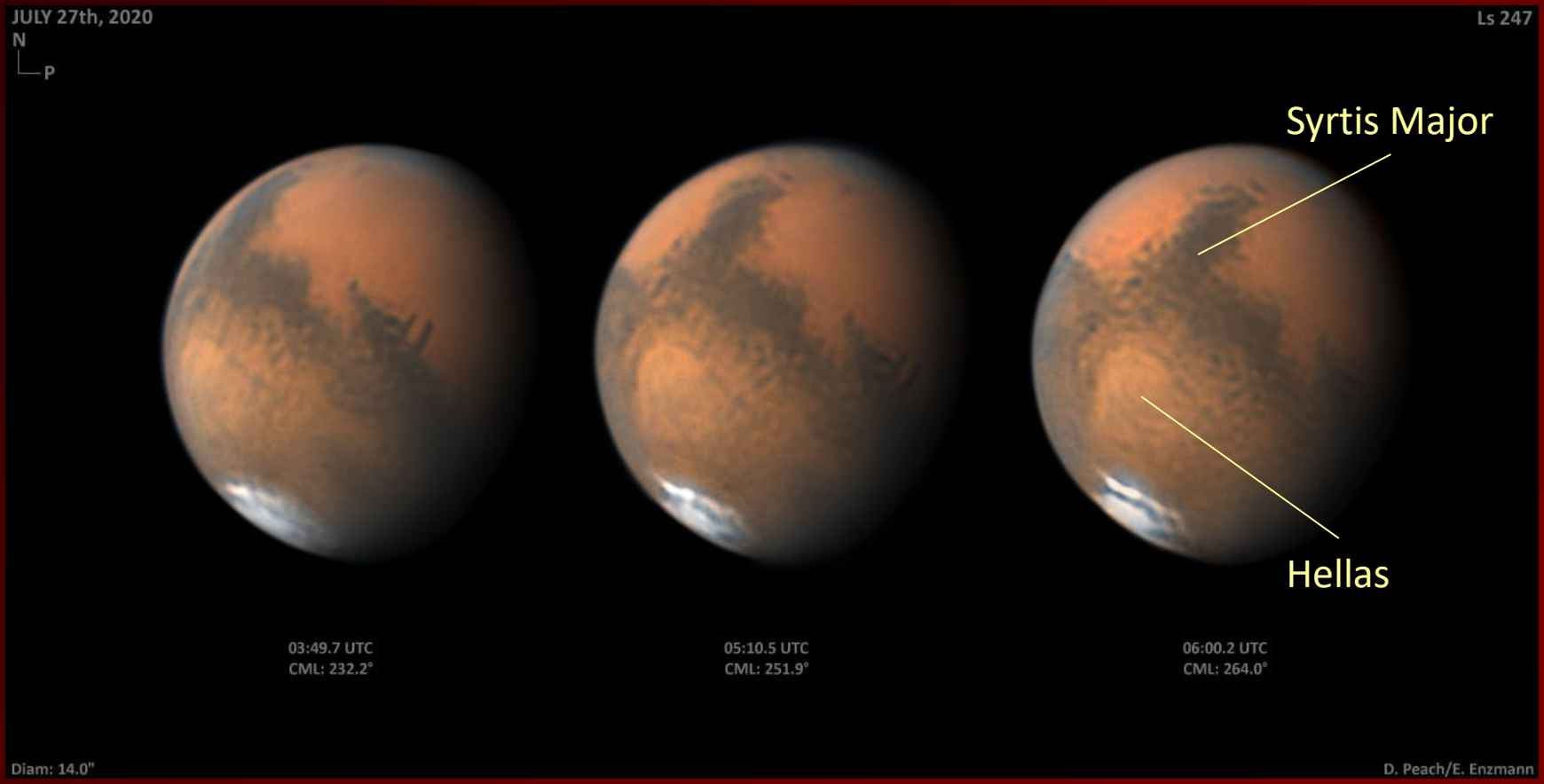
- Largest volcano in the solar system
- 3x taller than Everest
- Covers an area the size of France

Everything All Together

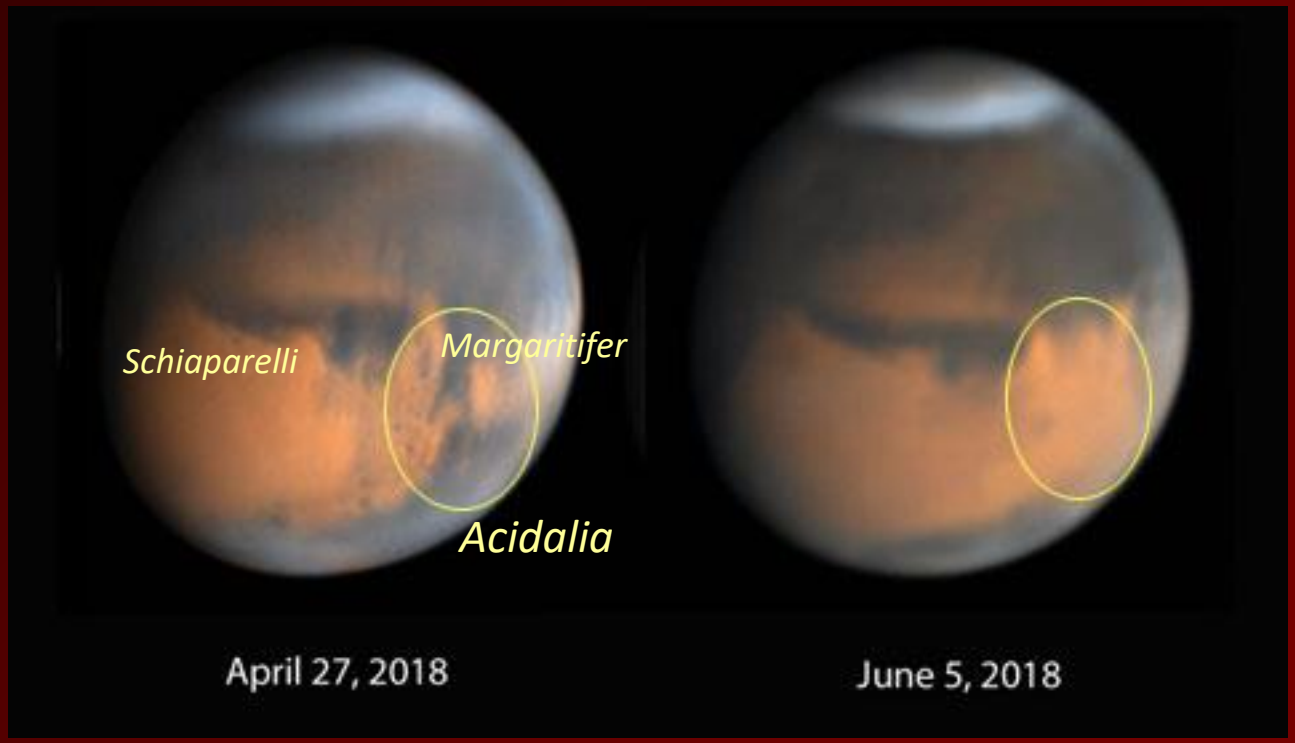


Your Martian Geography Quiz

Where Are We? [1]

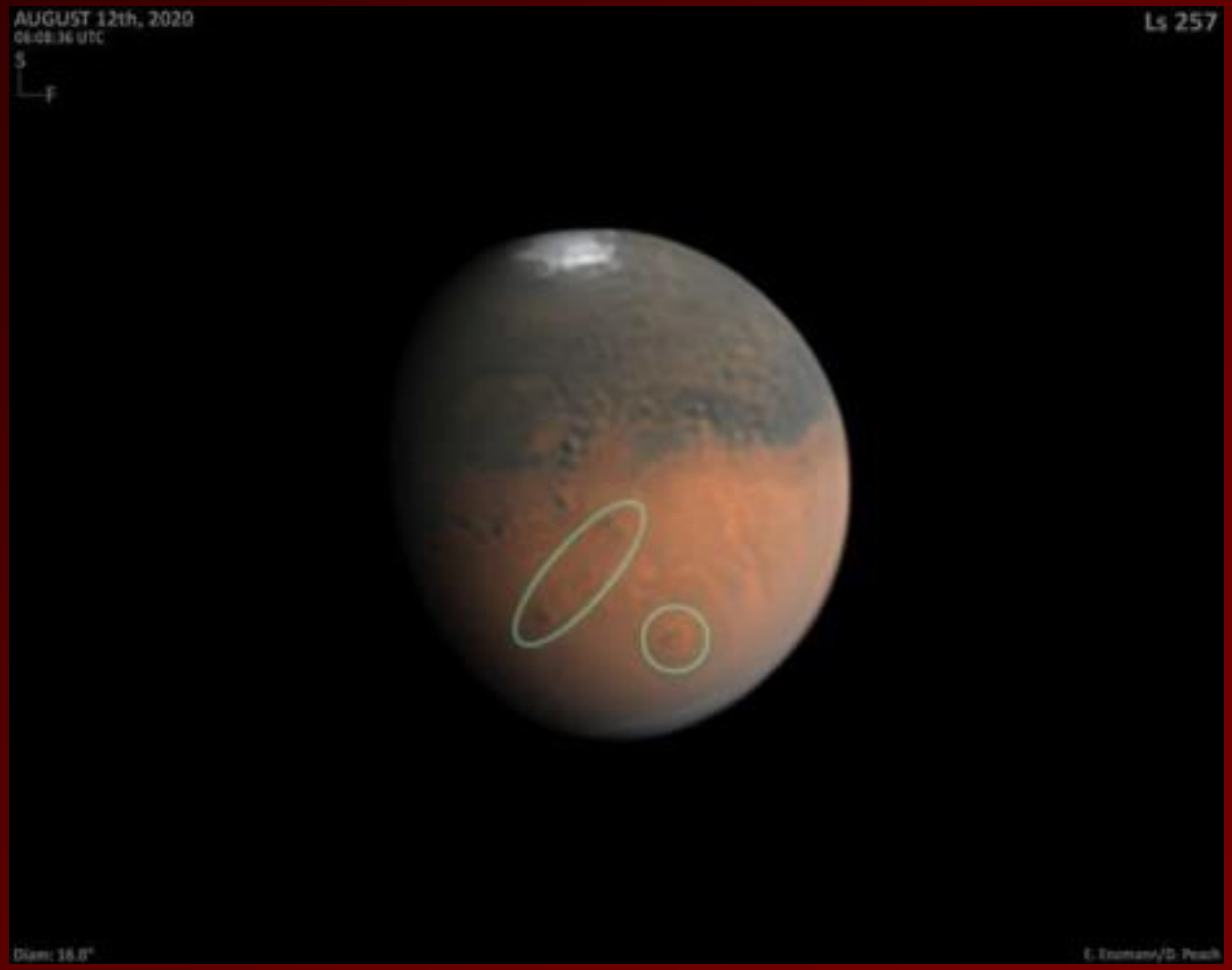


Where Are We? [2]



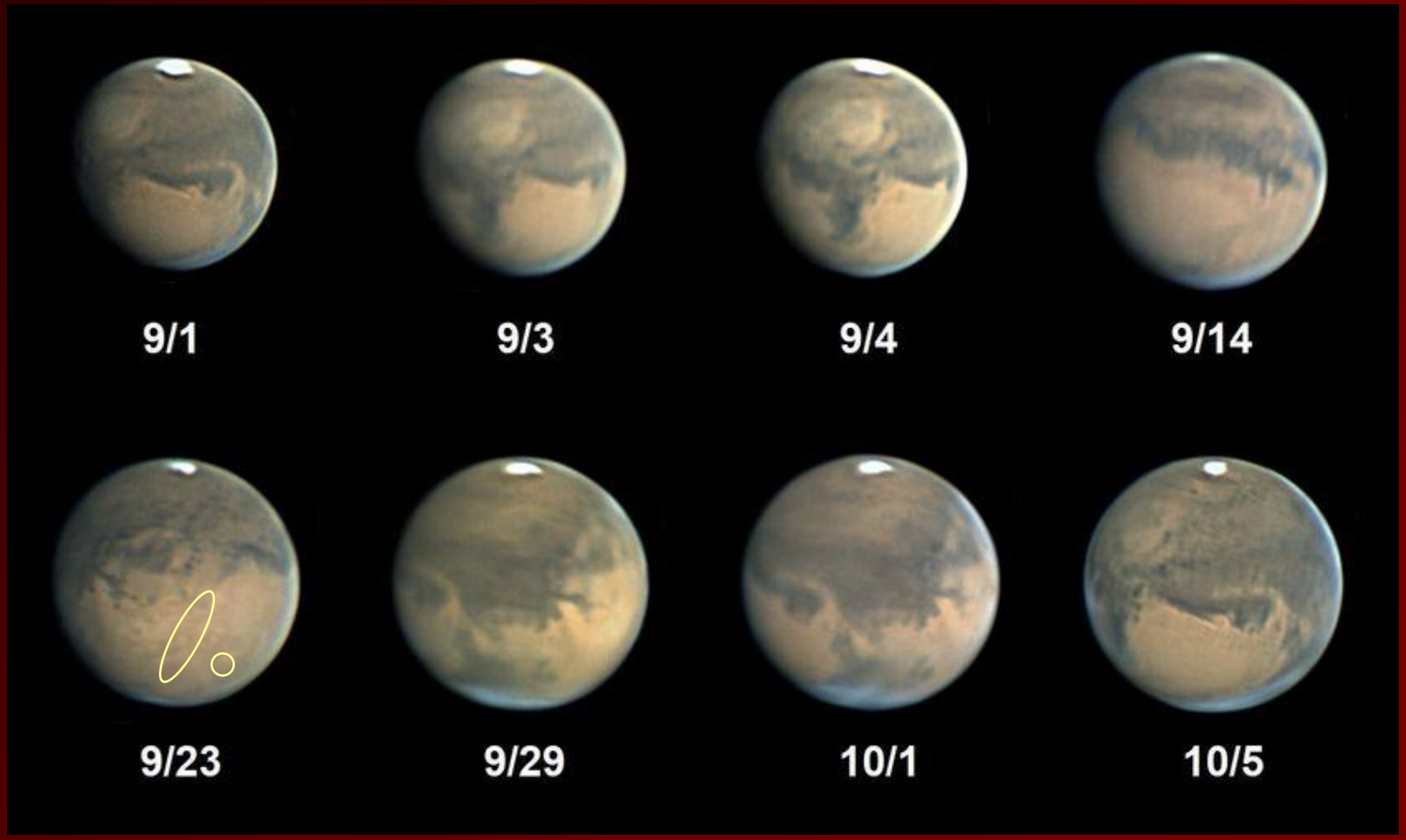
South is Up

Where Are We? [3]



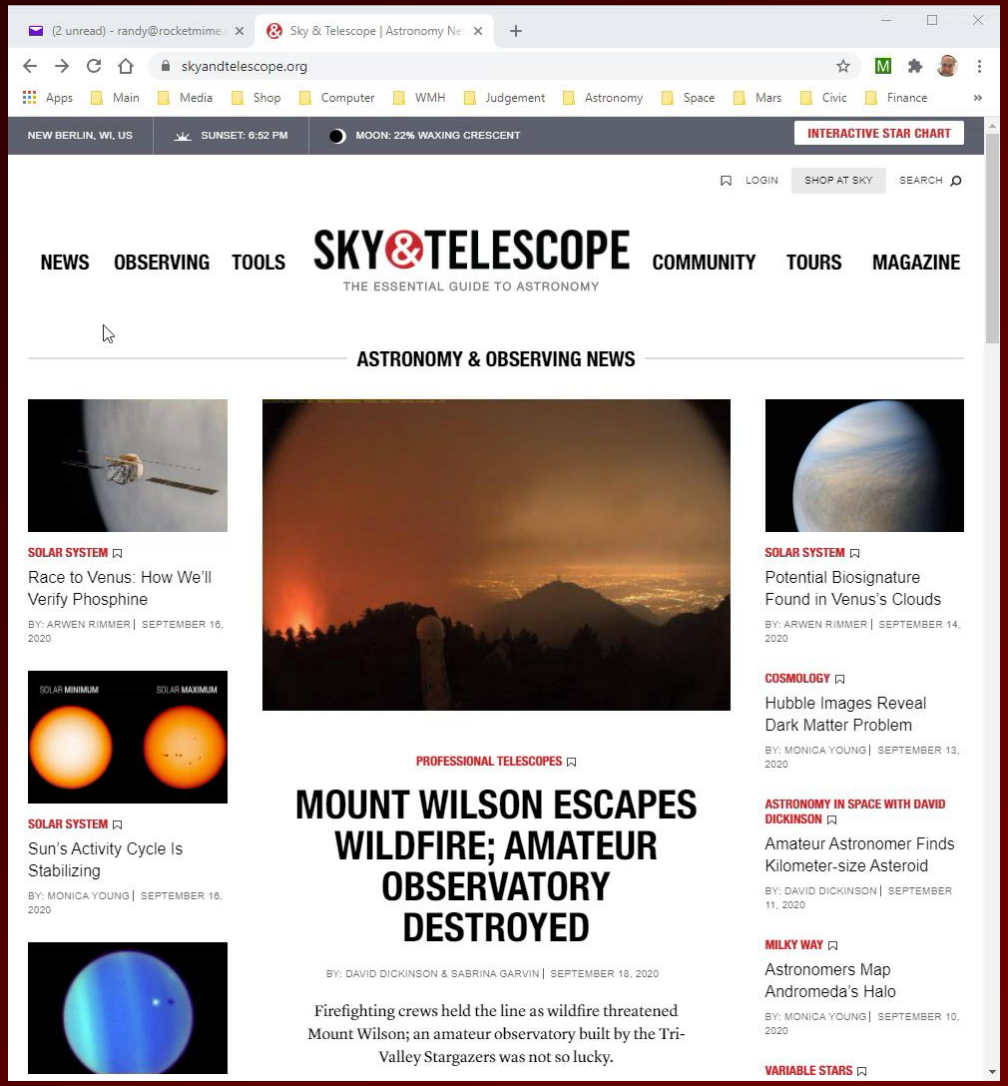
South is Up

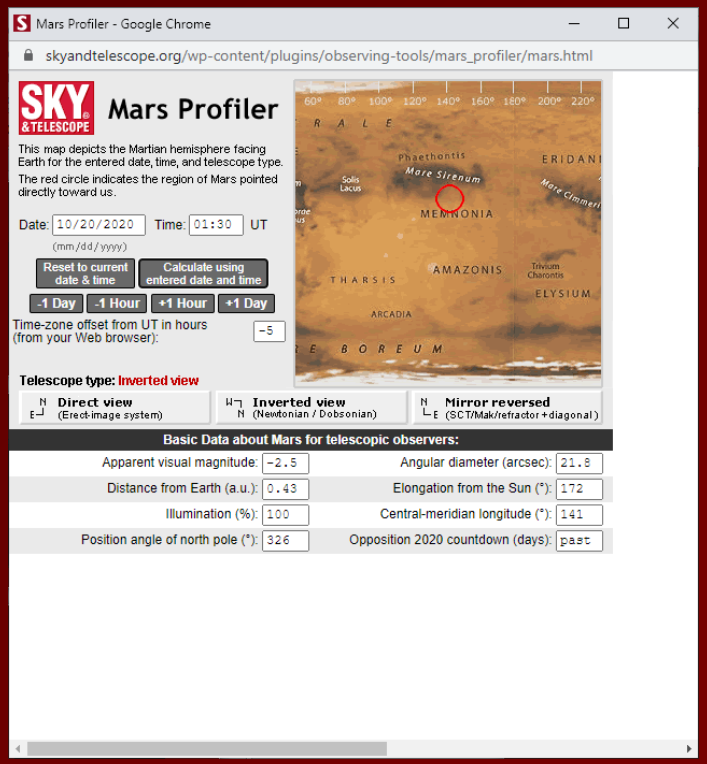
Where Are We? [4]



Lee Keith using A-Scope: 12.5 inch f/8.71 Newtonian reflector

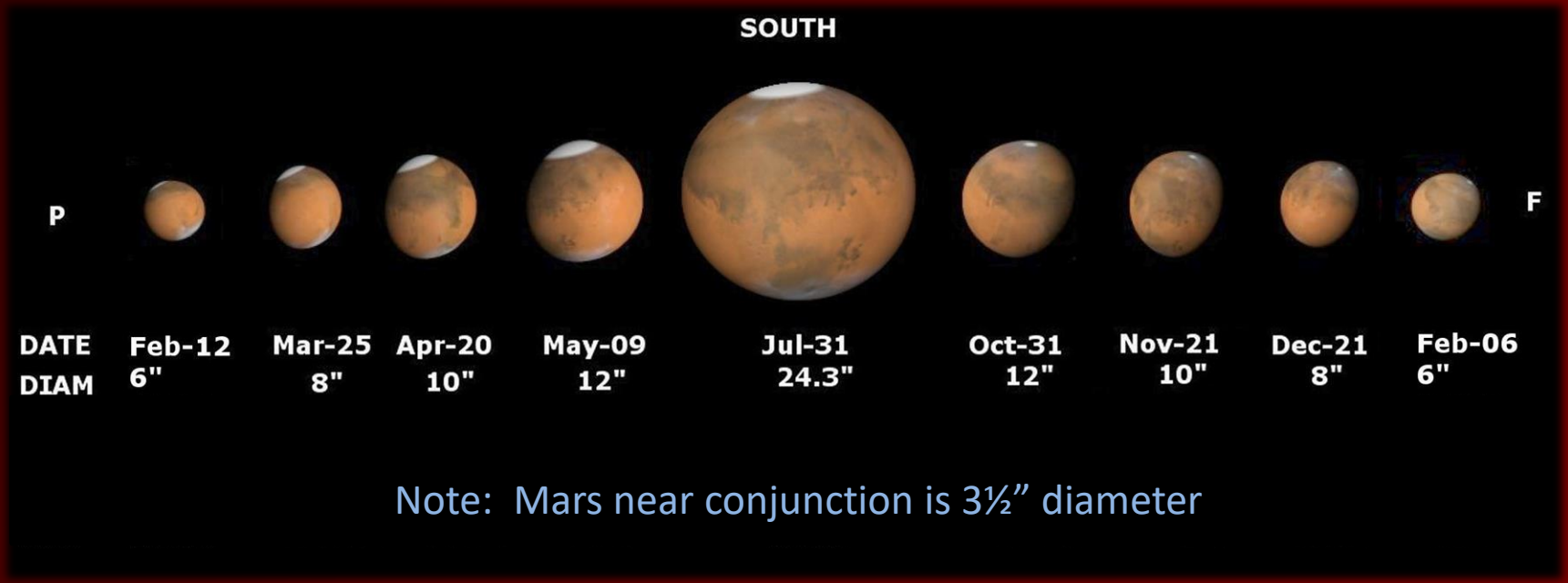
Oh, Sure, NOW You Tell Us





How Much Detail Can I See?

Mars Opposition 2018



Note: Mars near conjunction is 3½” diameter

Resolving Power of Your Scope

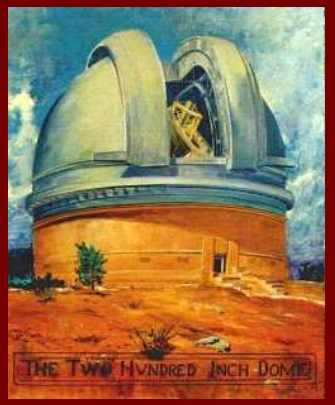
$$P_R = \frac{120}{D_O}$$

P_R is in arc-seconds, with D_O in mm

Telescope (inches)	Telescope (mm)	P_R (arc-sec)
4	100	1.2
6	150	0.8
10	250	0.5

Sure We Can Breathe, But...

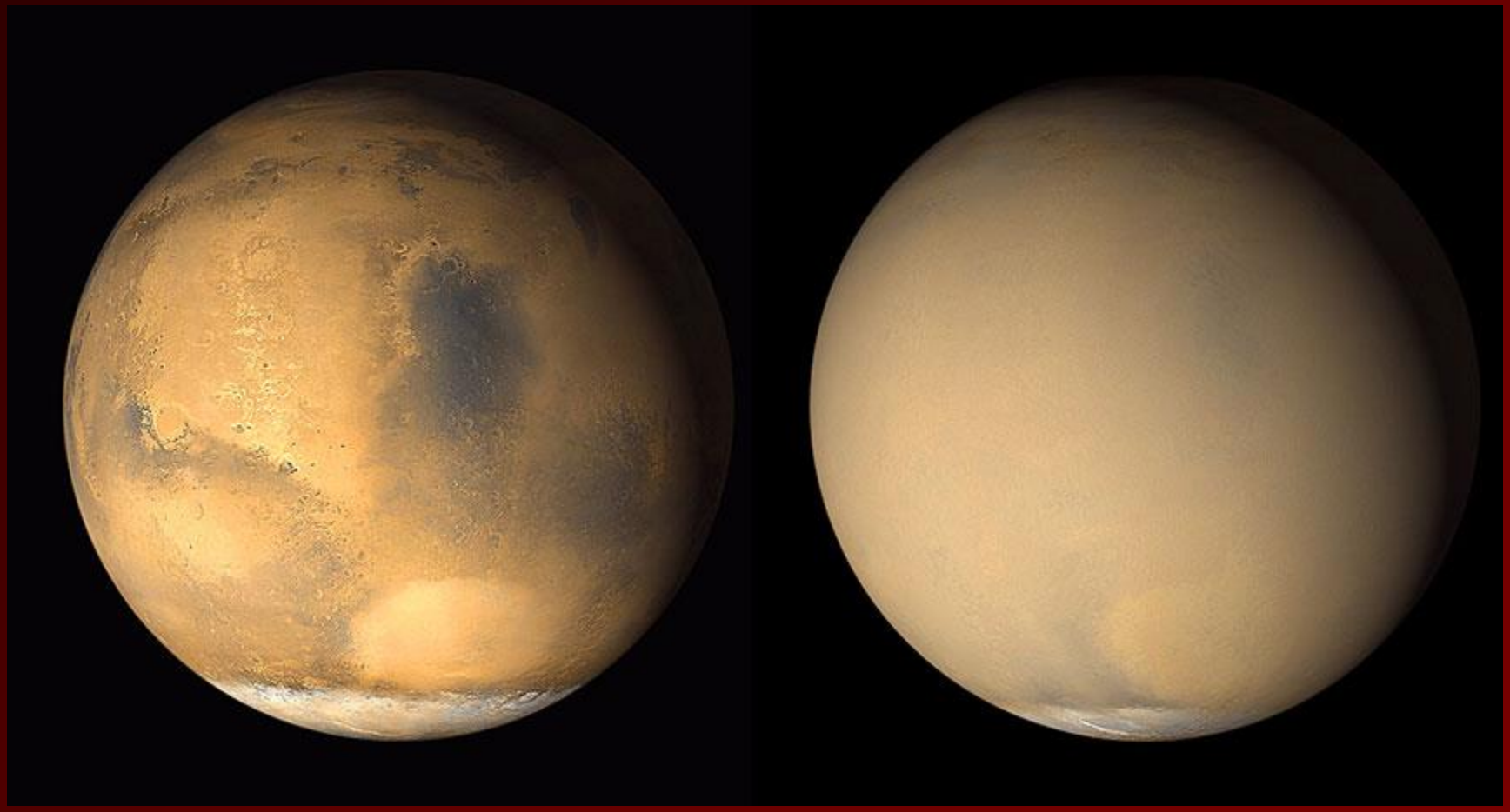
- Atmospheric conditions are described in terms of “transparency” and “seeing”
- Transparency translates to the faintest star that can be seen
- Seeing indicates the resolution that the atmosphere allows due to turbulence
- Typical is 2-3 arcseconds, a good night is 1 arcsec, Mt. Palomar might get 0.4.



The View in the Scope

Shot taken by
Ron Lundgren

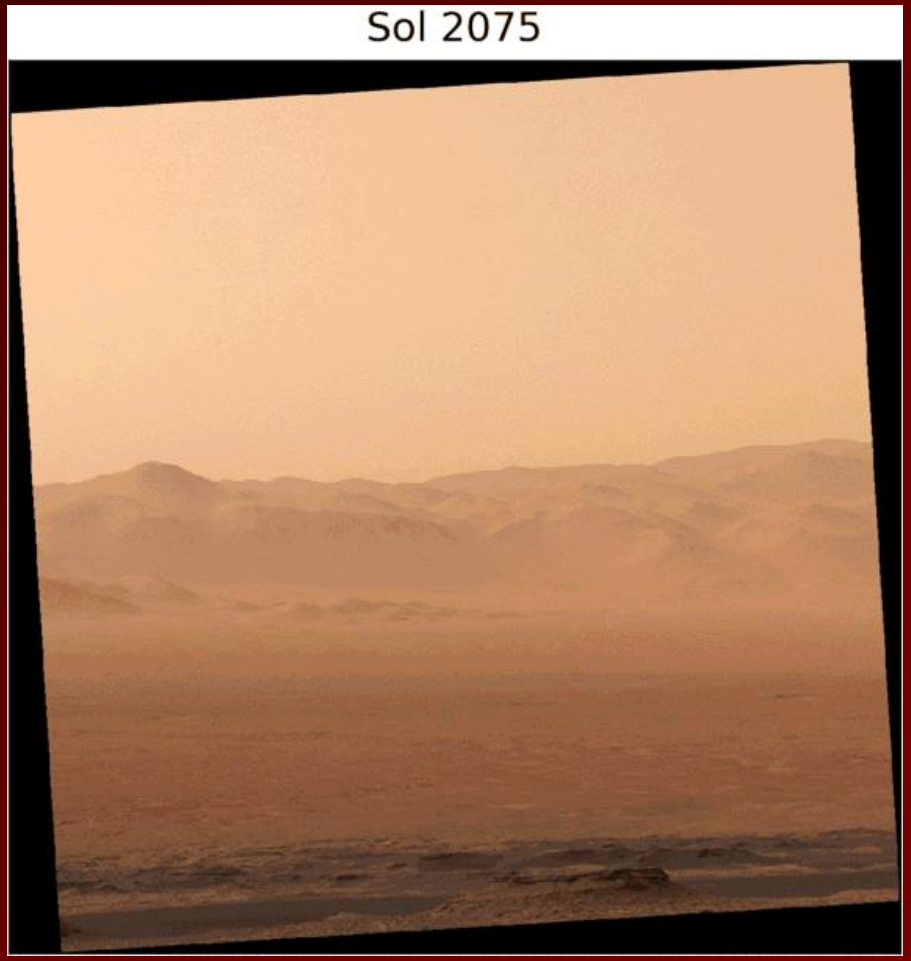
Hope for Good Weather



Not just on our planet…

What Did That Look Like on Mars?

Curiosity Rover

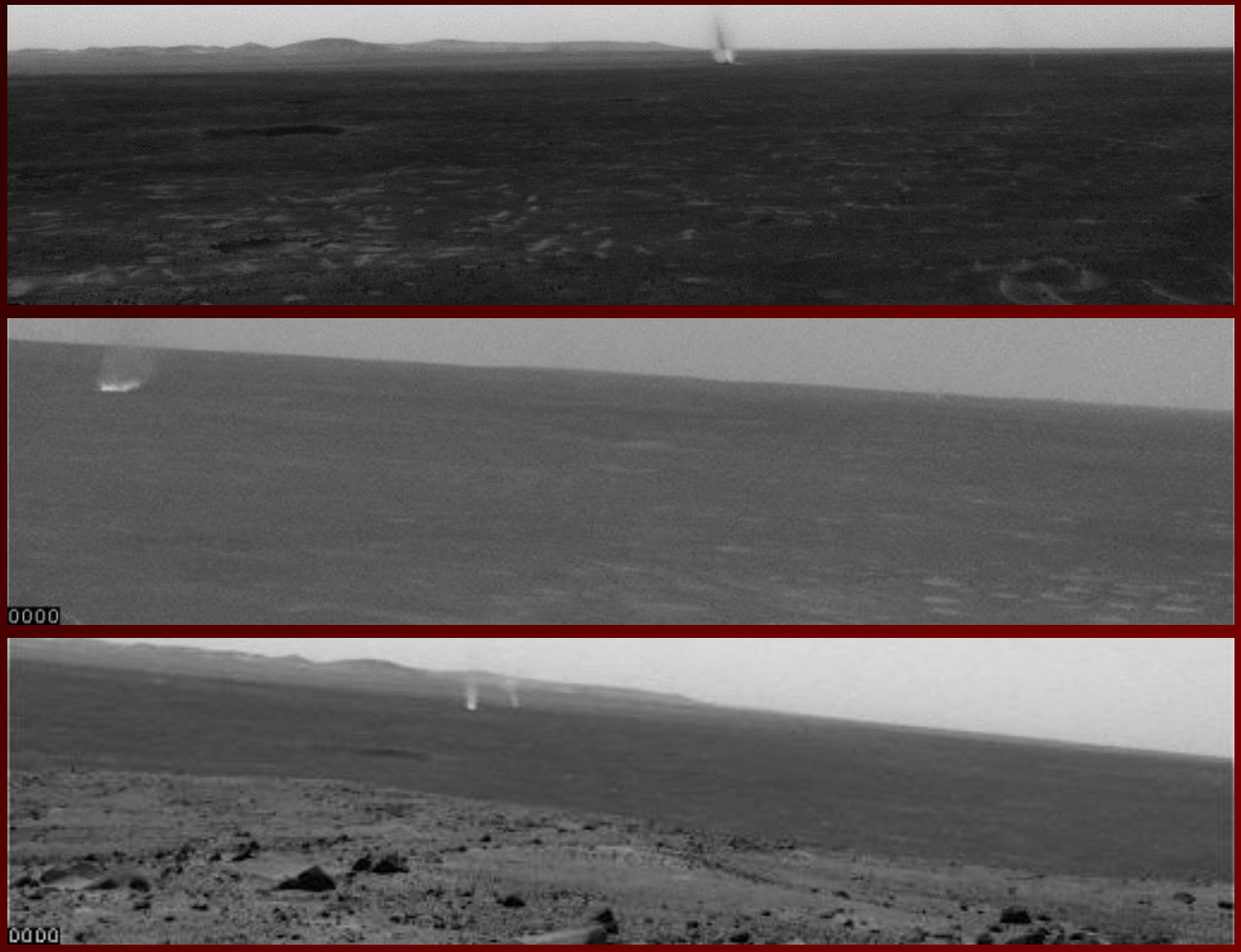


June 8, 2018 to Sept. 13, 2018

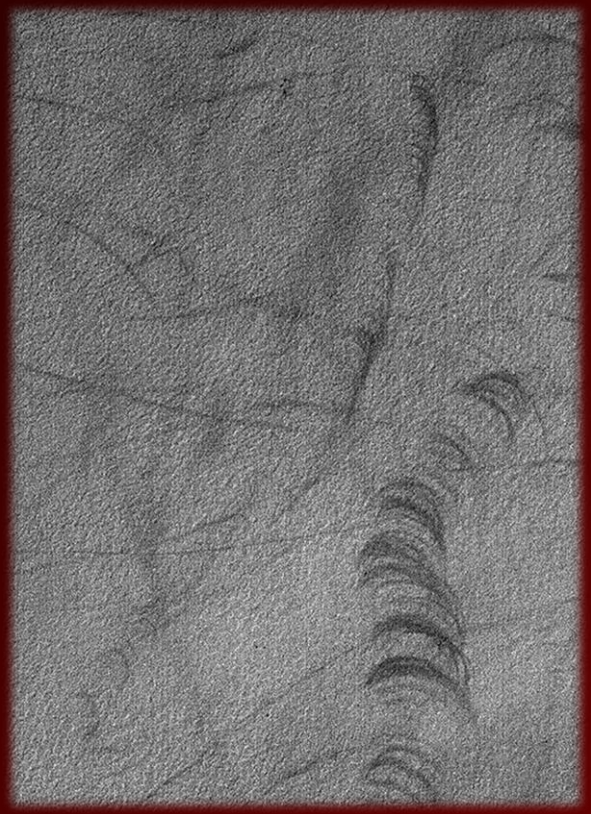
What's It Like 'Outside' on Mars?

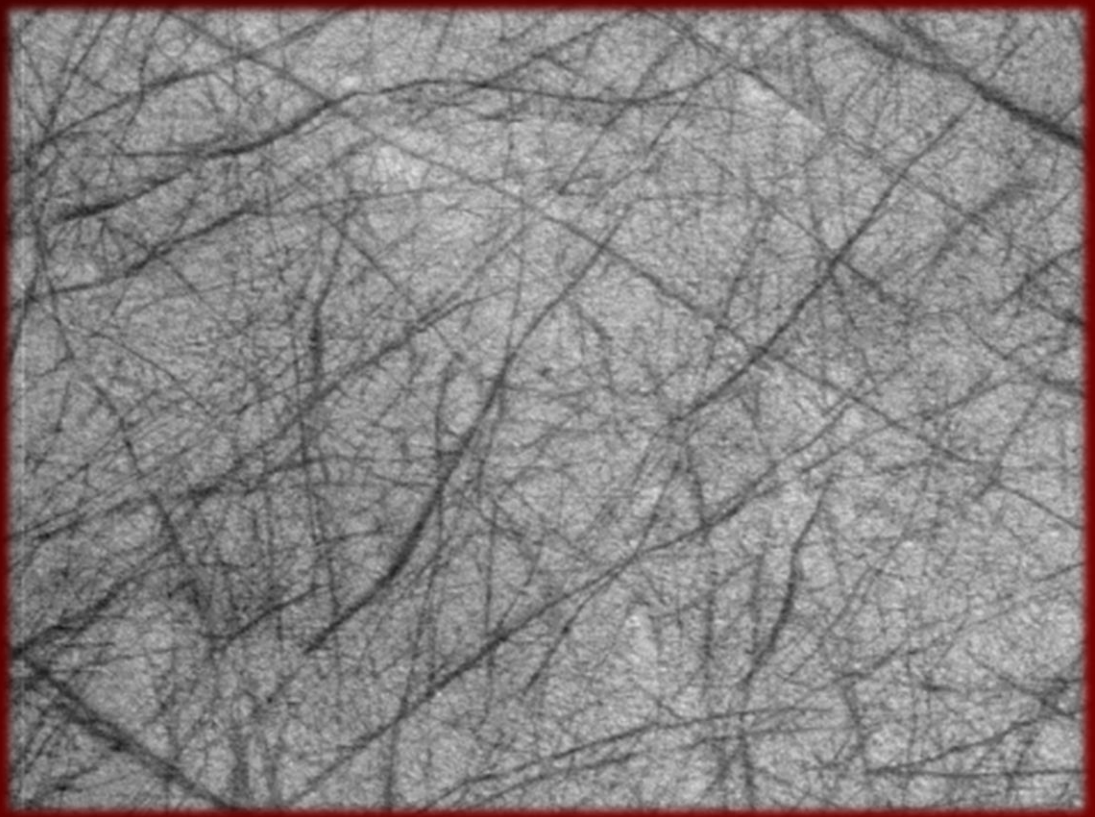
- 96% CO_2, 2% Nitrogen, 2% Argon
- Daily pressure around 6 - 7 mbars
  - Compare to Earth's average 1013 mbars at sea level
  - Less than 0.1 psi (Earth is 14.7 psi)
- Average -80°F
  - around -200°F at the poles
  - can get up to around 70°F at the equator
- Winds around 10-20 mph
  - up to 70 mph during dust storms
- Winds up to 200 mph inside dust devils

Land of Dust Devils



Dust Devil Tracks

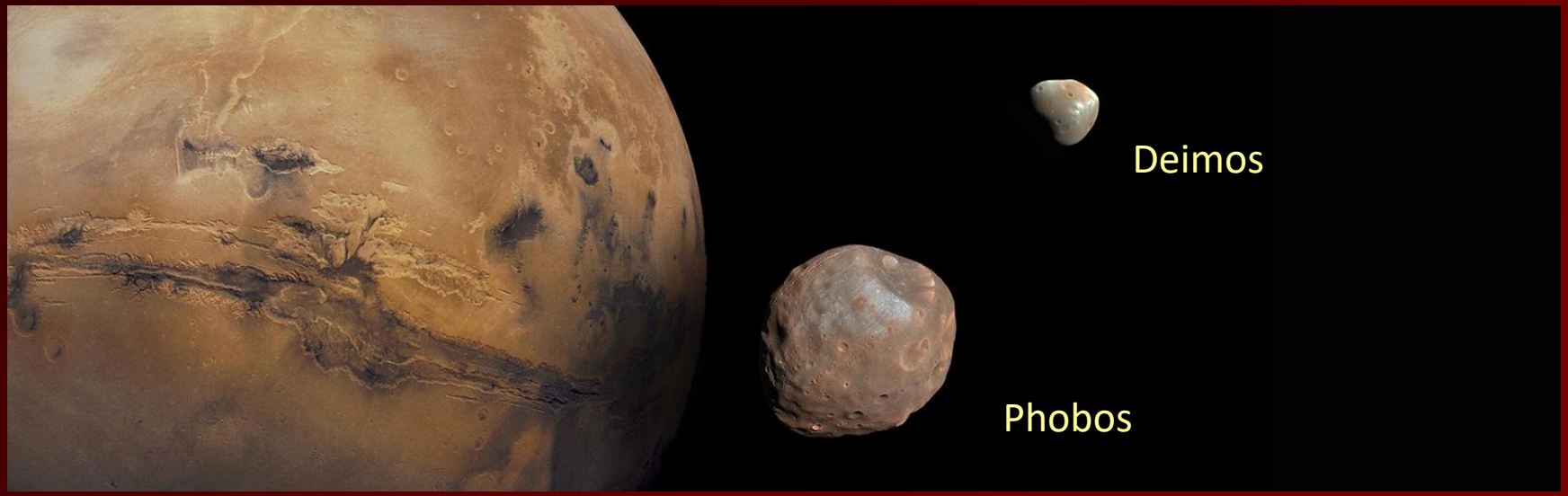




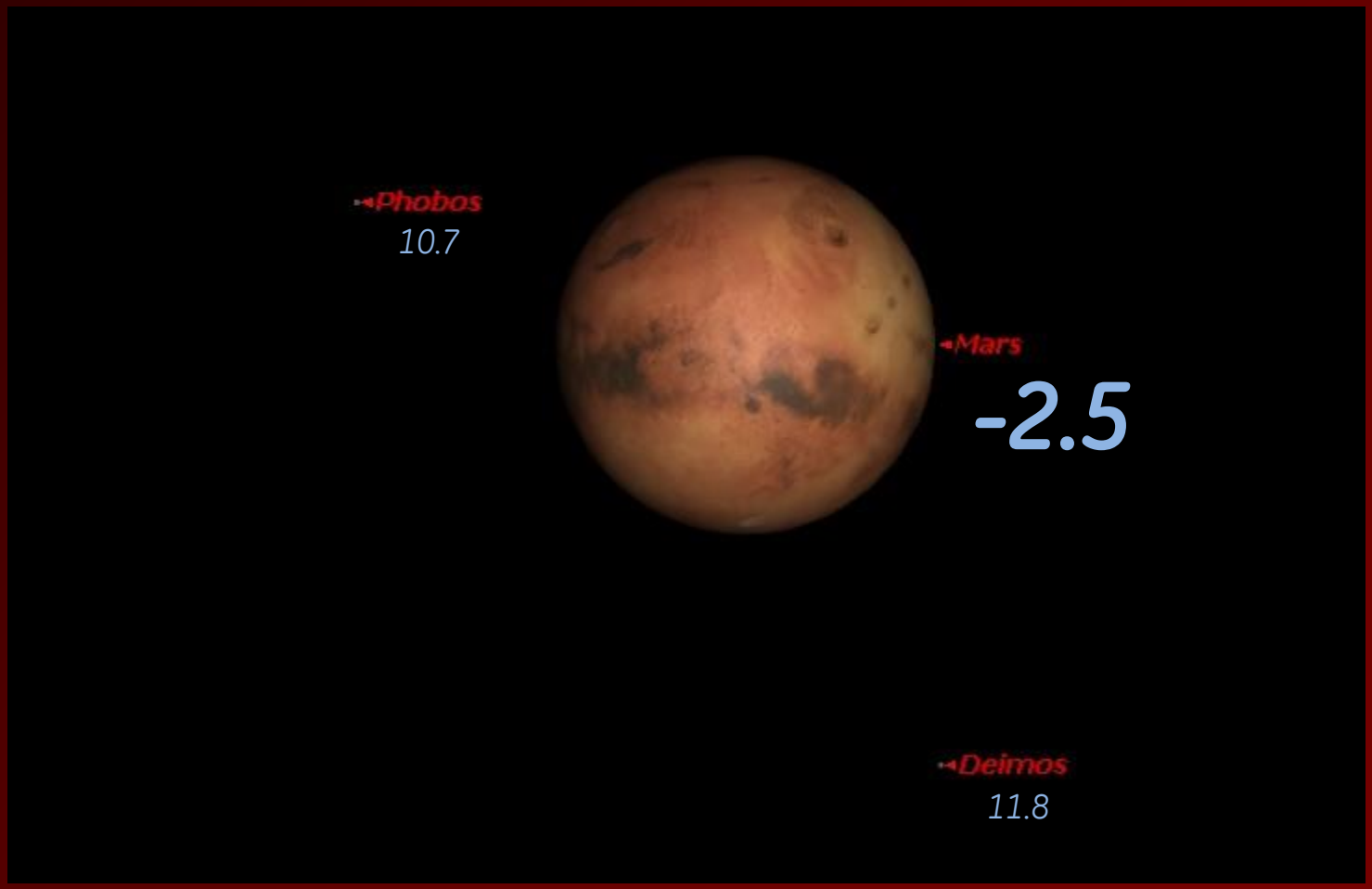
Dust Devil: View from Above

Mars Reconnaissance Orbiter

Doesn’t Mars Have Moons?



...And Can I See Them?



As Seen from Mars

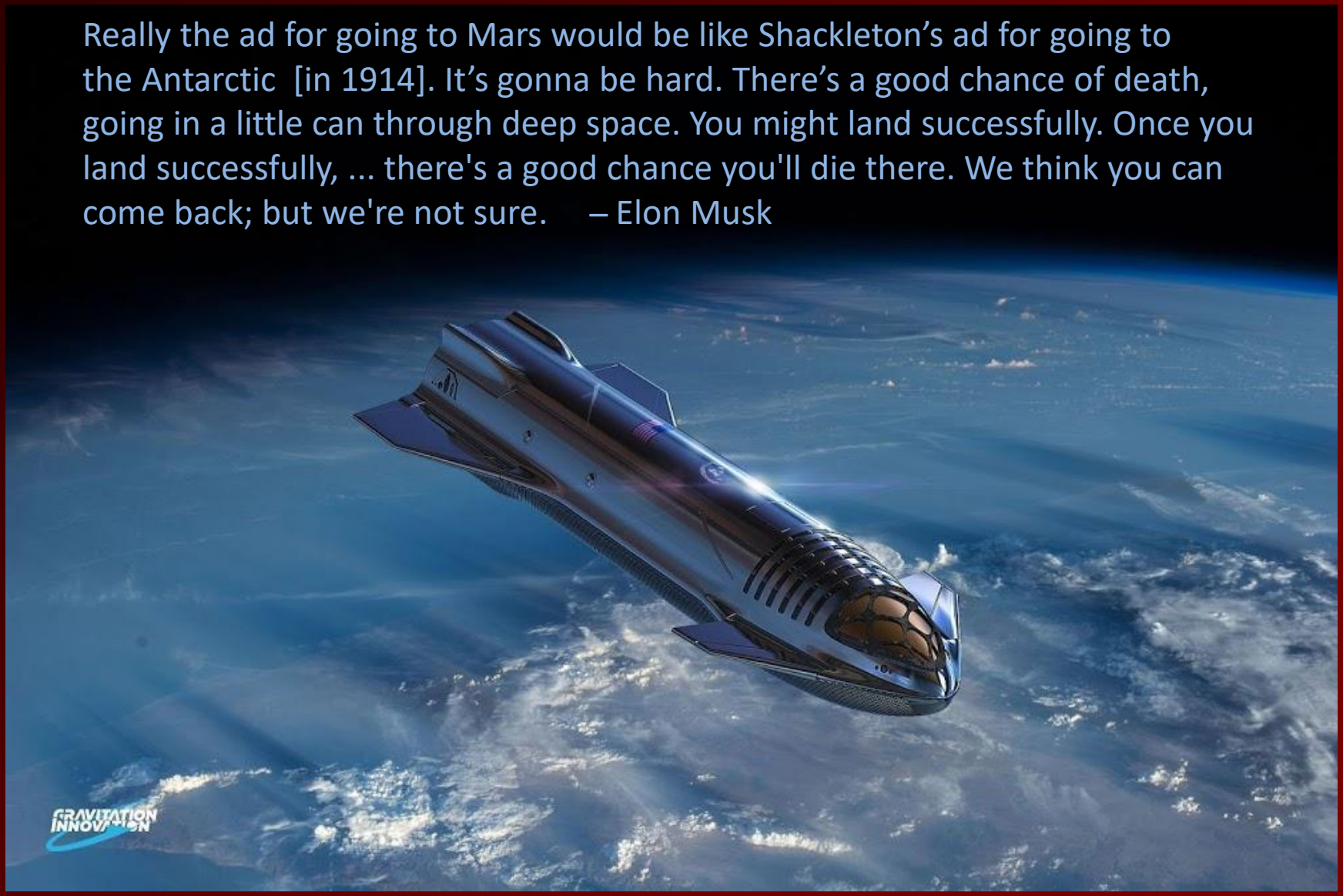
Deimos Eclipsed by Phobos
as seen by Curiosity

Deimos & Phobos from Mars

Compared to the Moon from Earth

Getting to Mars

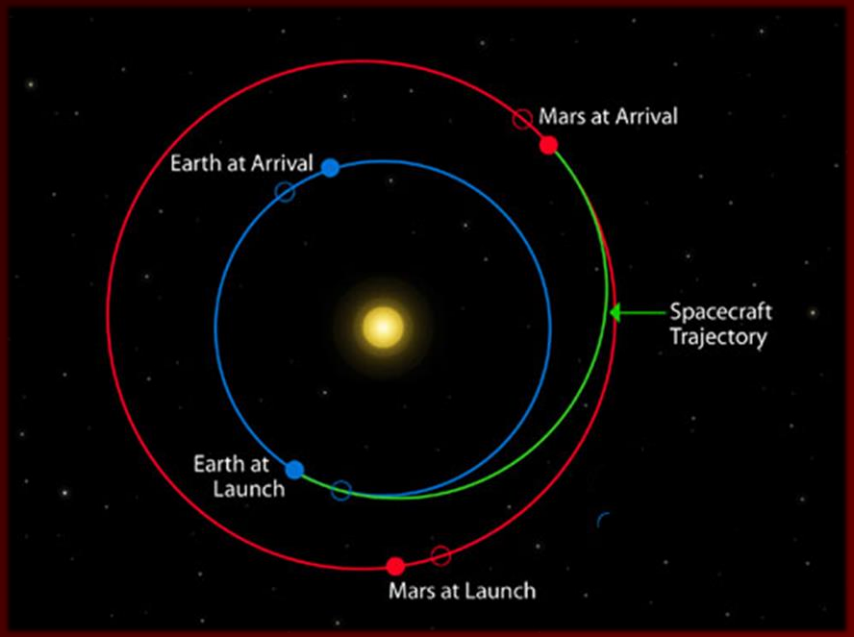
Really the ad for going to Mars would be like Shackleton's ad for going to the Antarctic [in 1914]. It's gonna be hard. There's a good chance of death, going in a little can through deep space. You might land successfully. Once you land successfully, ... there's a good chance you'll die there. We think you can come back; but we're not sure. – Elon Musk



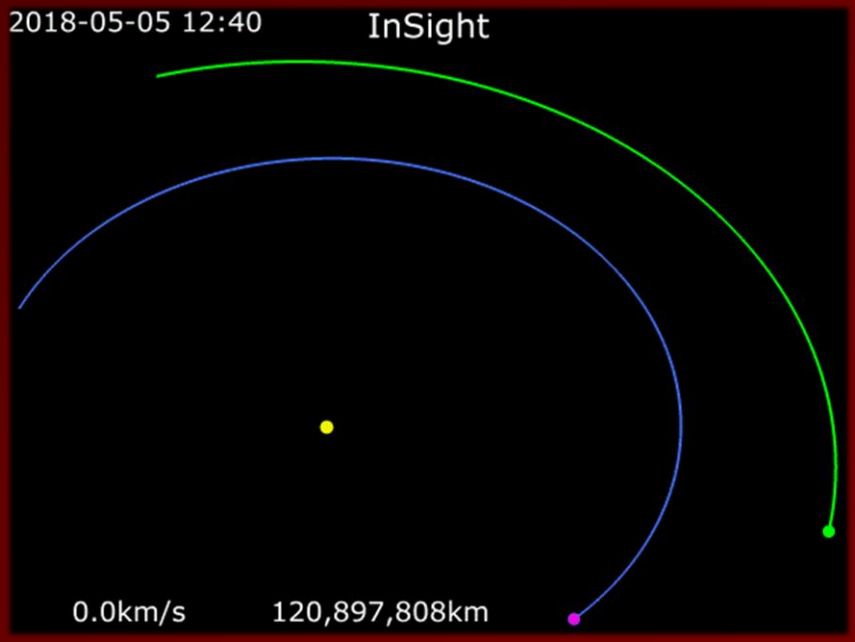
Your Starship

Comparison to Saturn V

Transfer Orbit

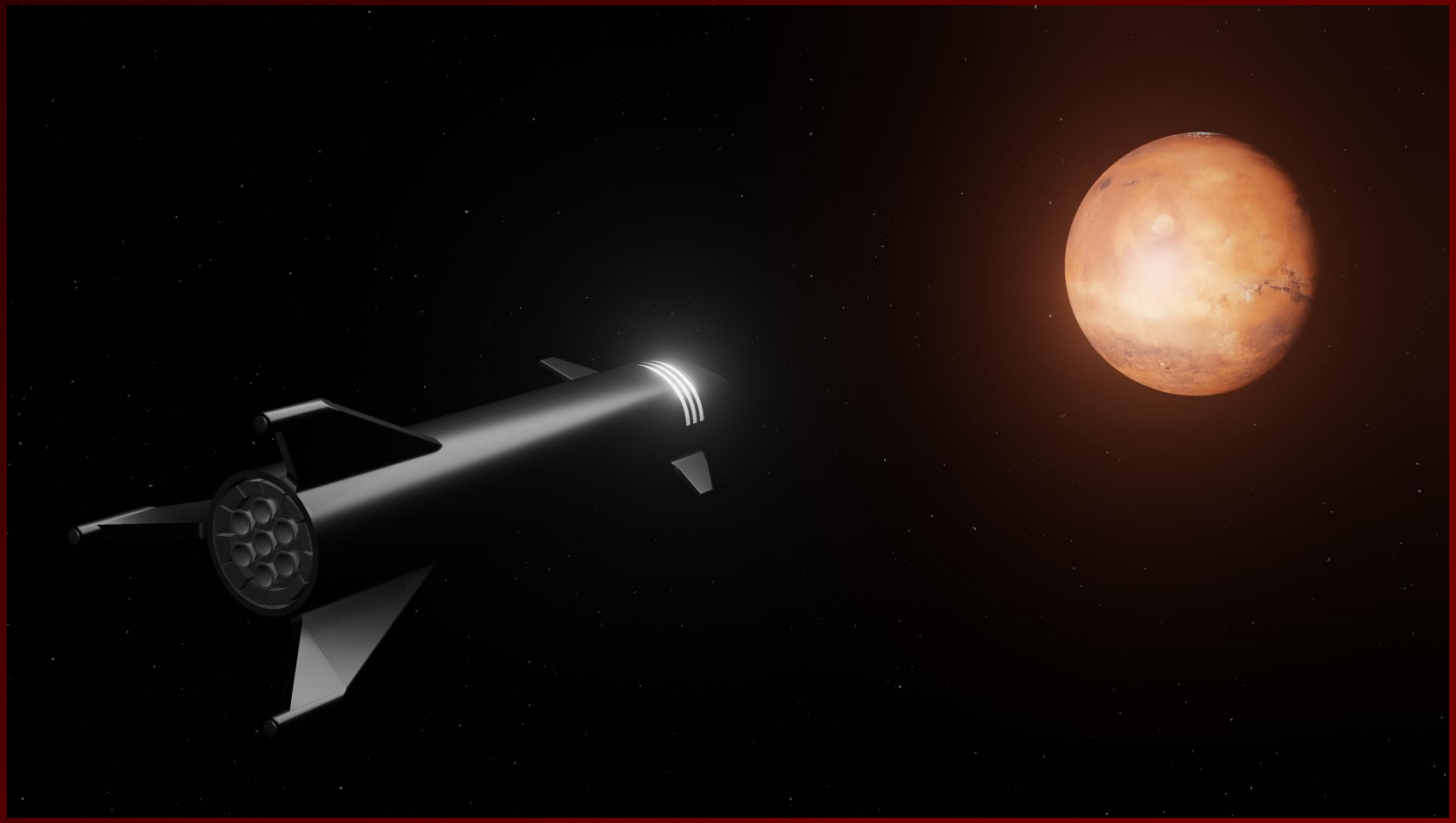


Spirit's & Opportunity's Journeys to Mars



InSight's Journey to Mars

Mars Approach



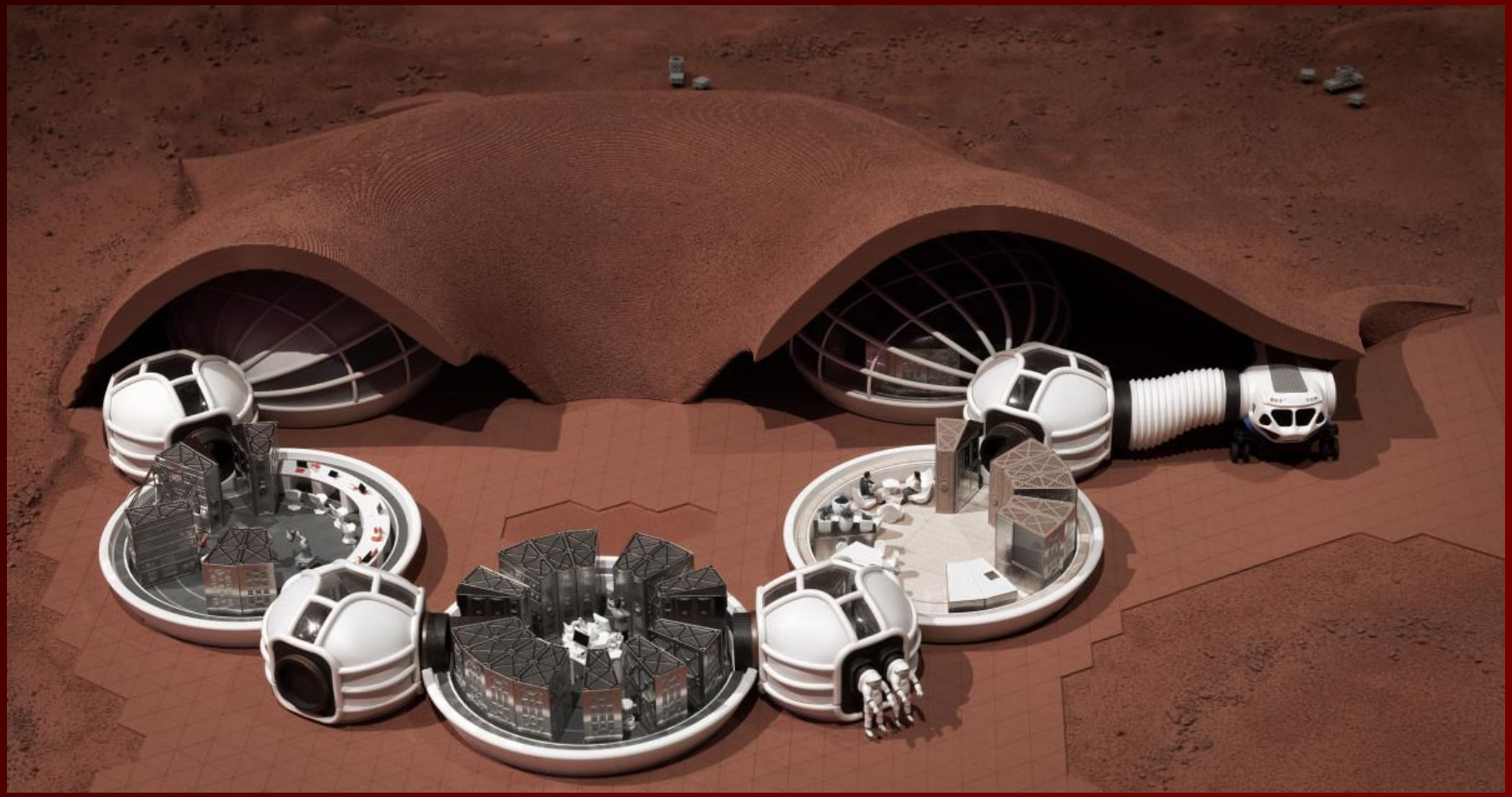
Mars Entry

Landing First Supply Ship

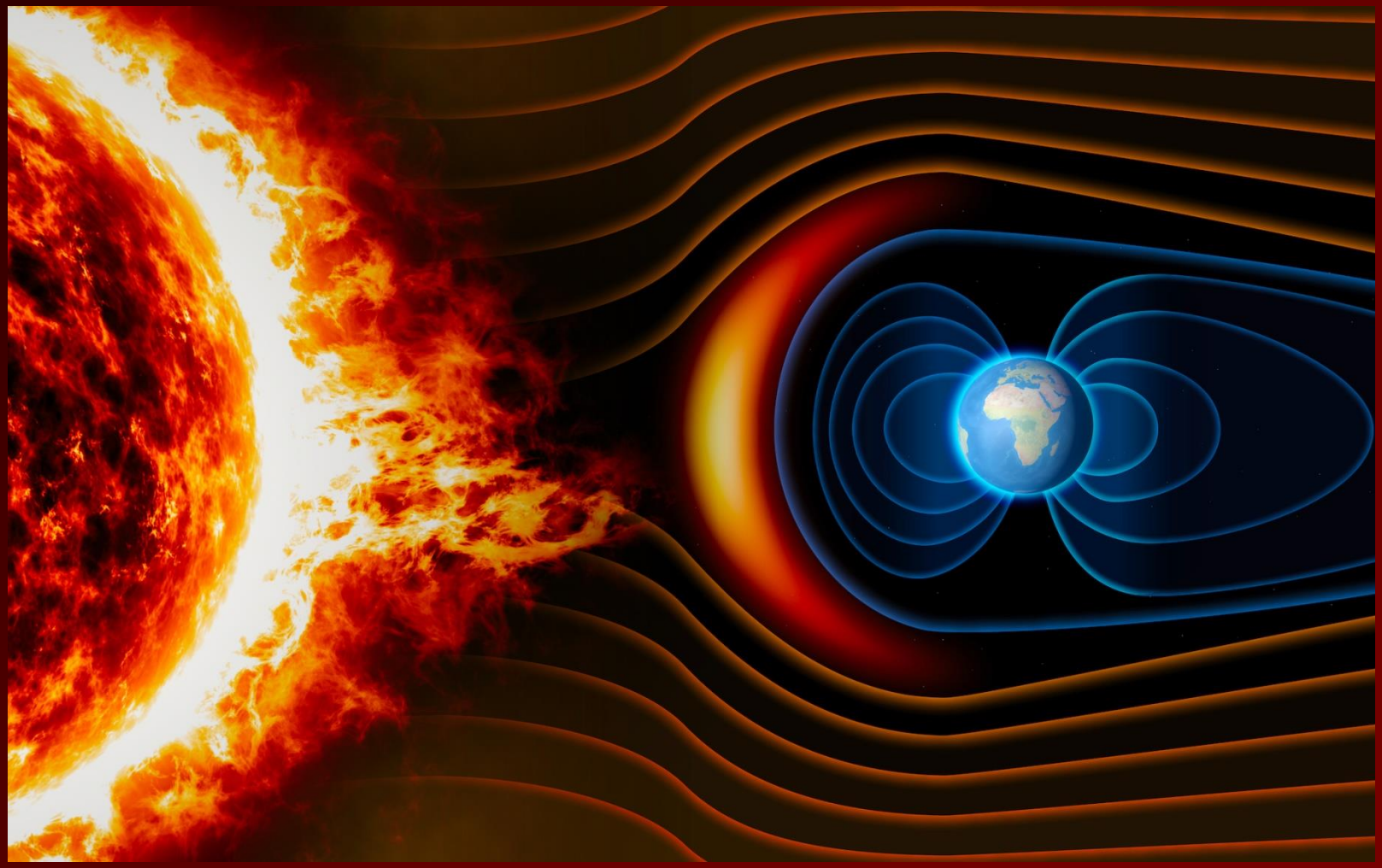
3D Printing the Shelters

Pressurized Habitat

Habitats Under Shelter

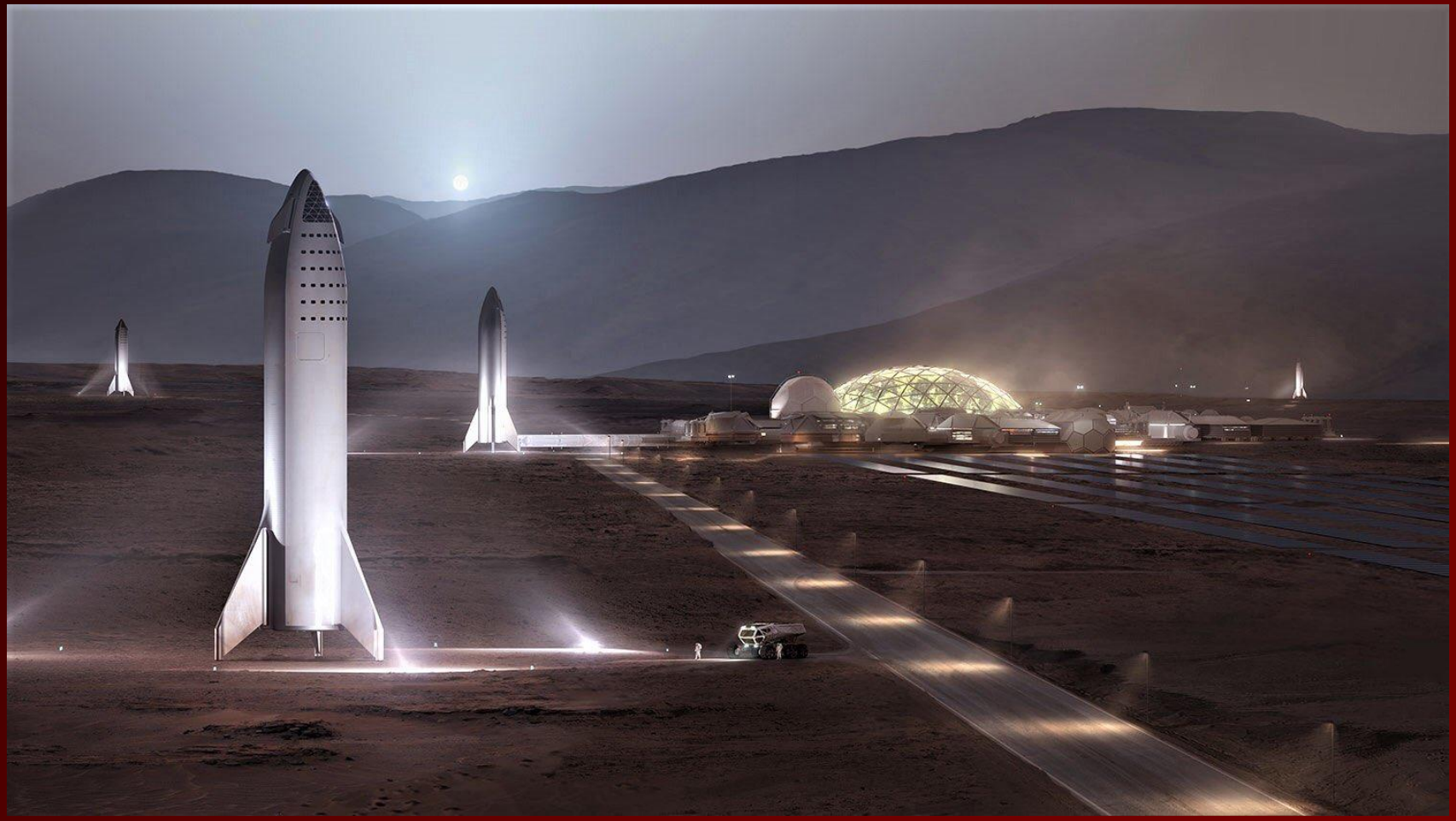


Protective Magnetic Field



Completed Mars Residence

Establishing a Mars Base



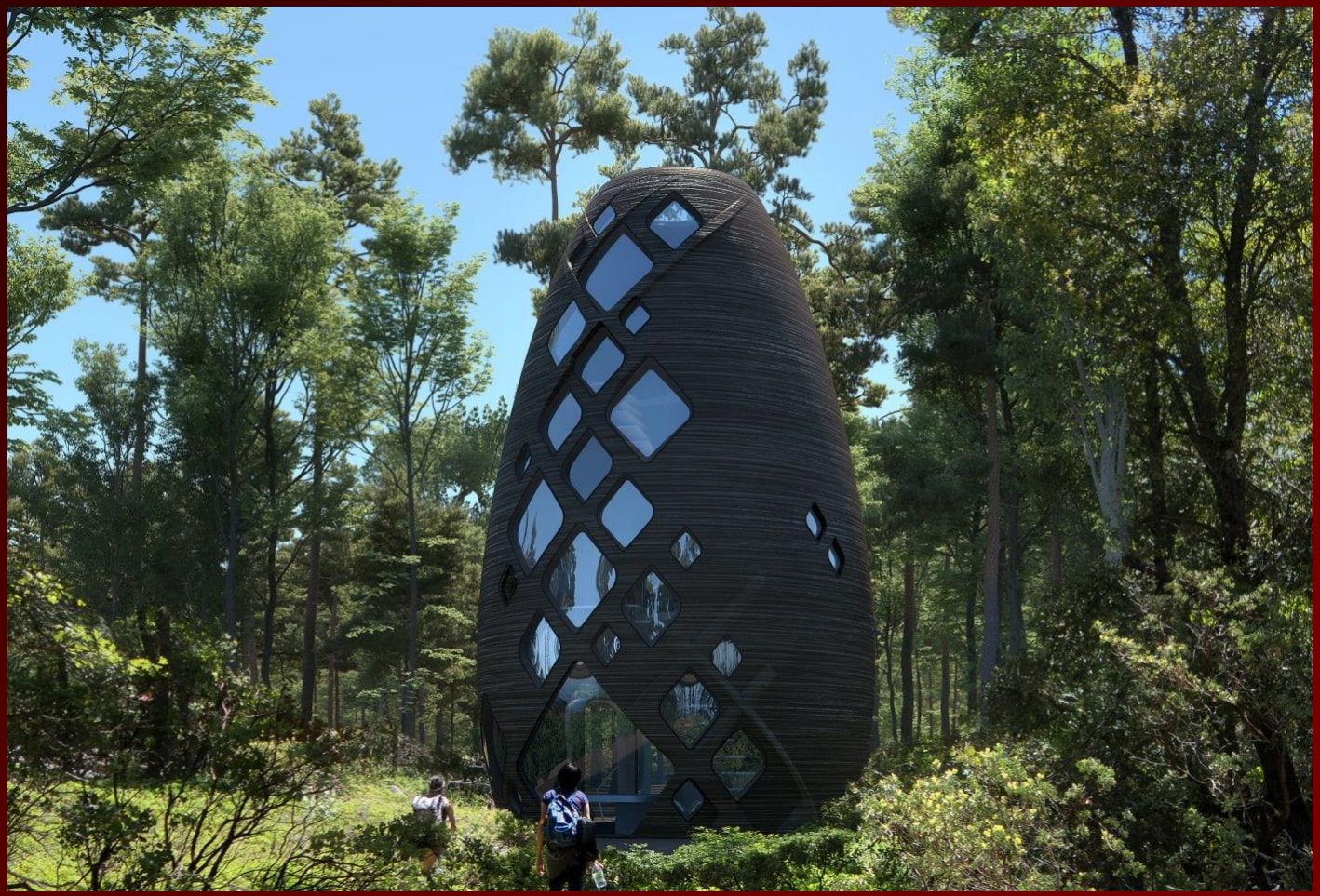
Building a Mars Colony

Fin

Appendix

MARSHA Design Habitat

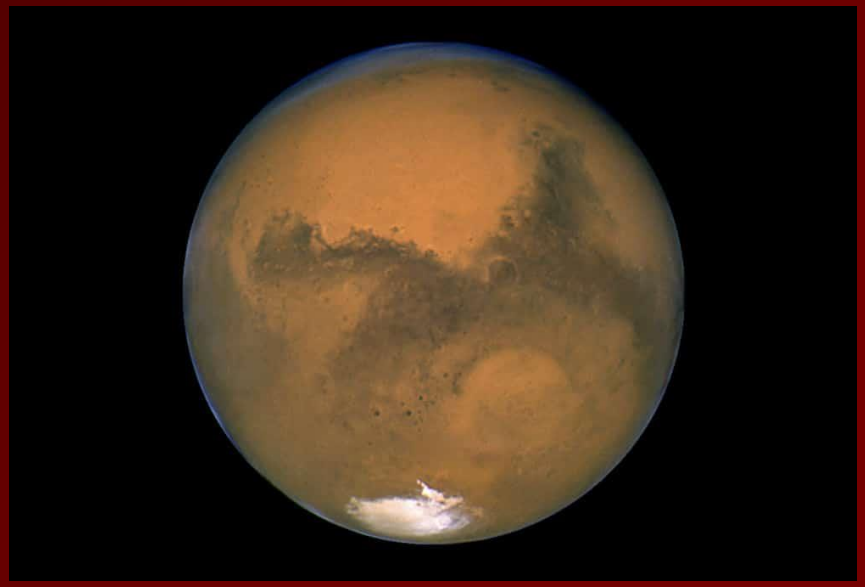
Tera



Syrtis Major on 30 September

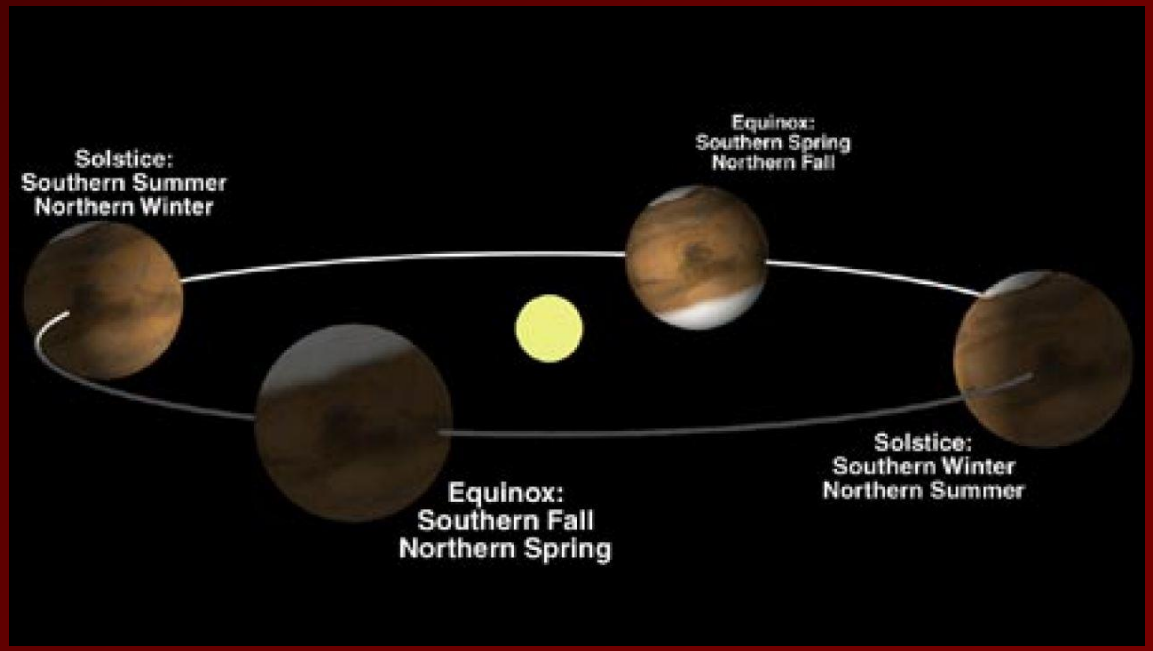
Which Polar Cap Is That?

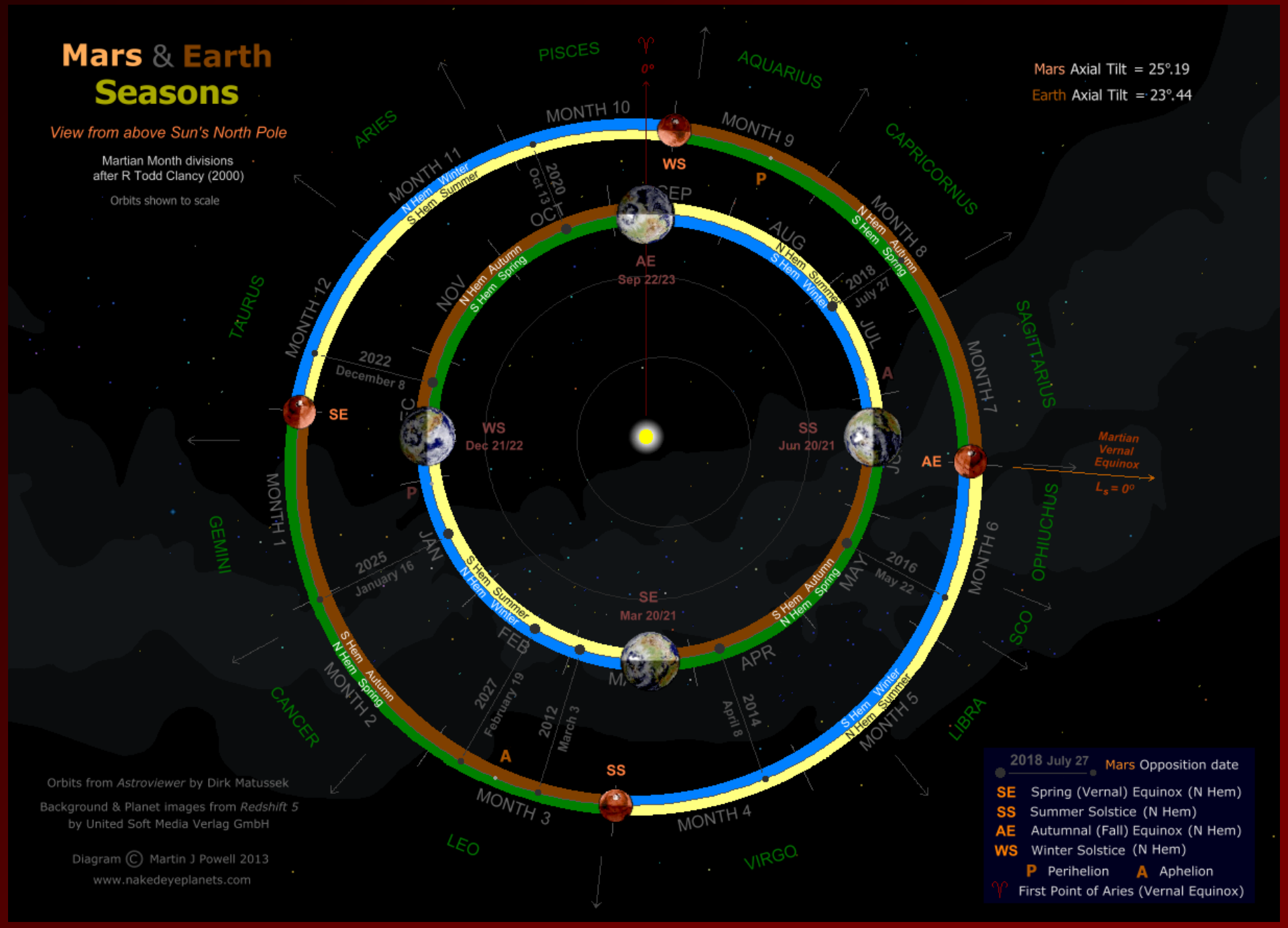
North Polar Cap



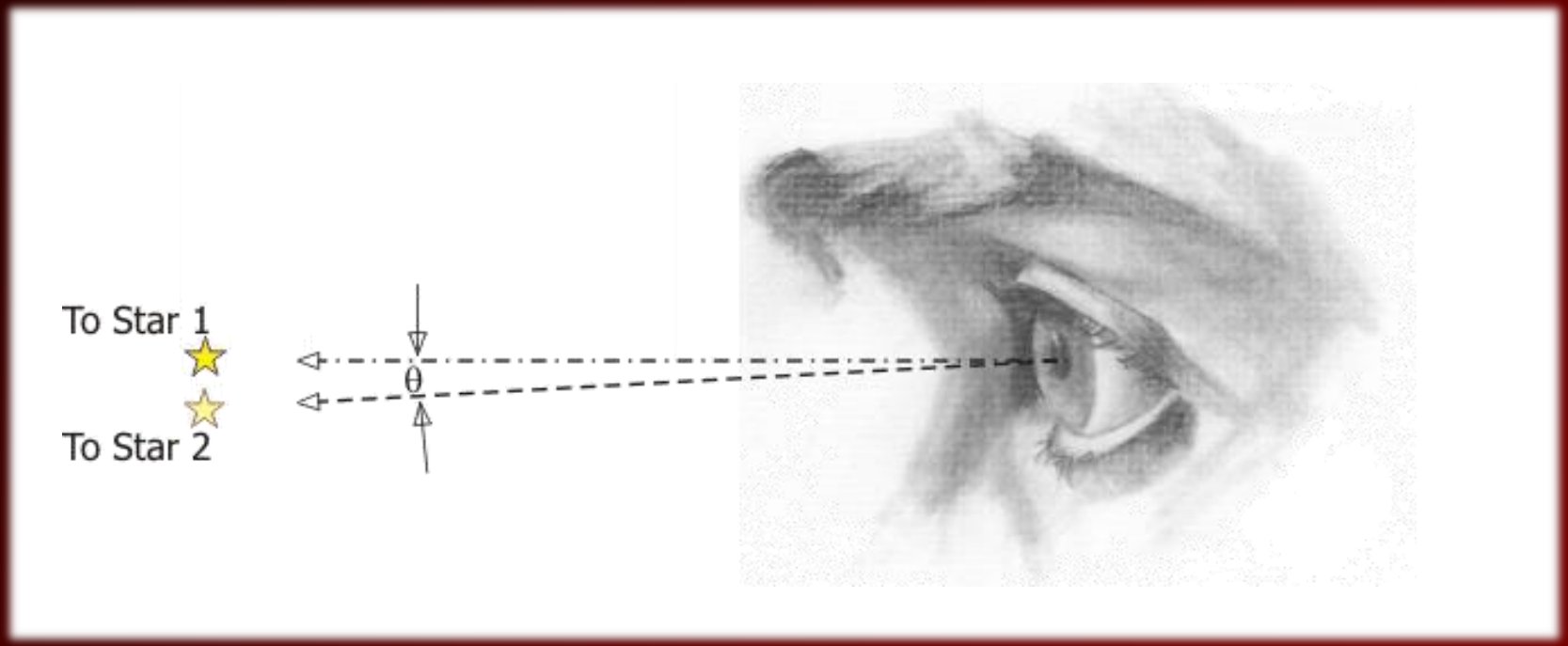
South Polar Cap

Mars Seasons



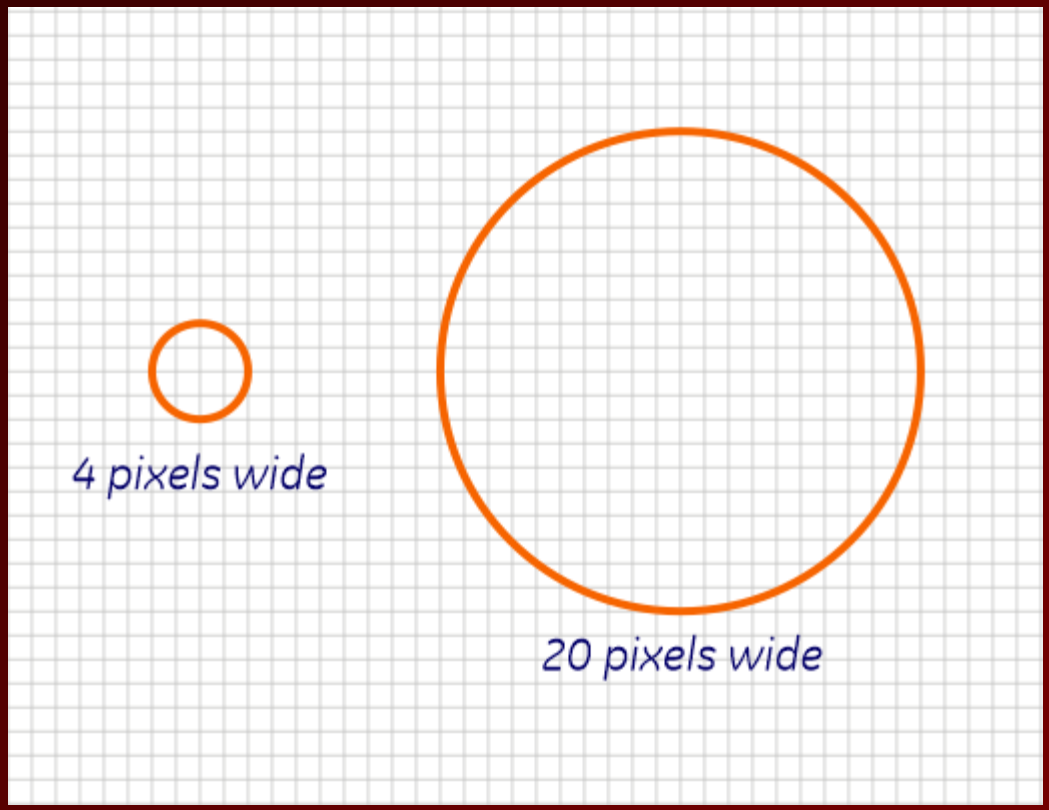

Mars & Earth Seasons
View from above Sun's North Pole
Martian Month divisions after R Todd Clancy (2000)
Orbits shown to scale
Mars Axial Tilt = 25°.19
Earth Axial Tilt = 23°.44
PISCES
AQUARIUS
CAPRICORNUS
SAGITTARIUS
OPHIUCHUS
SCO
LIBRA
VIRGO
LEO
CANCER
GEMINI
TAURUS
ARIES
MONTH 1
MONTH 2
MONTH 3
MONTH 4
MONTH 5
MONTH 6
MONTH 7
MONTH 8
MONTH 9
MONTH 10
MONTH 11
MONTH 12
0°
WS
P
AE
Sep 22/23
A
SS
Jun 20/21
AE
Martian Vernal Equinox
$L_s = 0^o$
SE
Mar 20/21
A
SS
WS
Dec 21/22
P
SE
2018 July 27
2016 May 22
2014 April 8
2012 March 3
2027 February 19
2025 January 16
2022 December 8
2020 Oct 13
N Hem Summer
S Hem Winter
N Hem Autumn
S Hem Spring
N Hem Spring
S Hem Autumn
N Hem Winter
S Hem Summer
2018 July 27 Mars Opposition date
SE Spring (Vernal) Equinox (N Hem)
SS Summer Solstice (N Hem)
AE Autumnal (Fall) Equinox (N Hem)
WS Winter Solstice (N Hem)
P Perihelion A Aphelion
First Point of Aries (Vernal Equinox)
Orbits from Astroviewer by Dirk Matussek
Background & Planet images from Redshift 5 by United Soft Media Verlag GmbH
Diagram © Martin J Powell 2013
www.nakedeyeplanets.com

Separation in Arc-Seconds

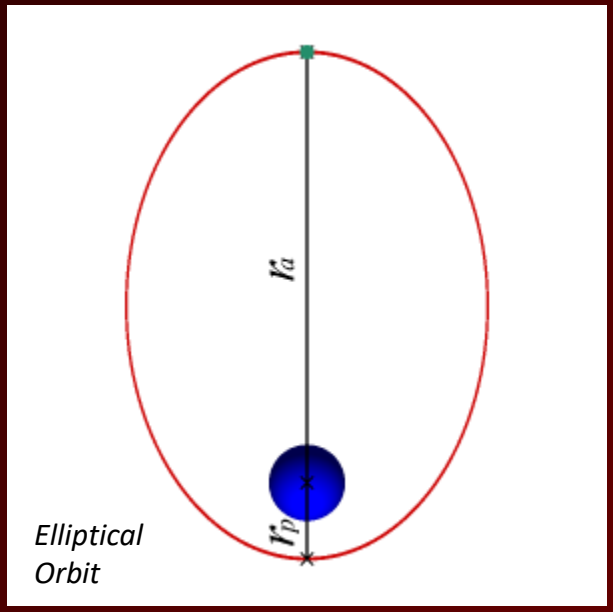


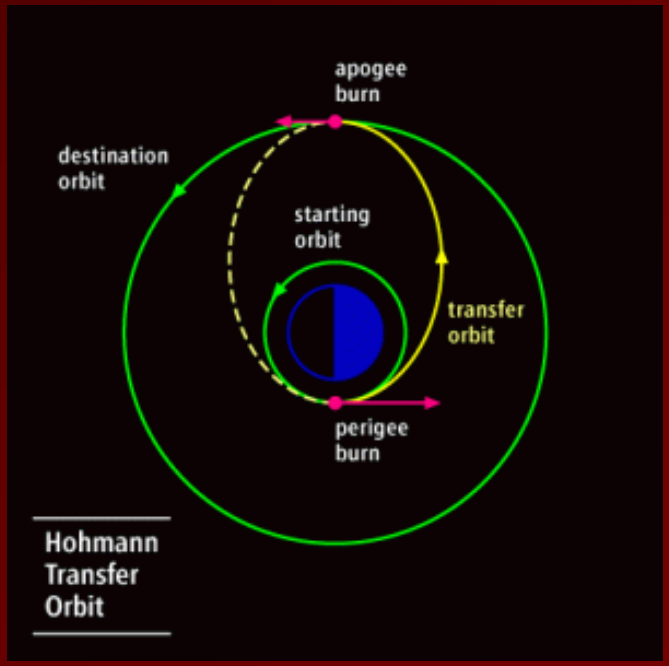
- Separation of stars is expressed as an angle.
- One degree = 60 arc-minutes
- One arc-minute = 60 arc-seconds
- Separation between stars is usually expressed in arc-seconds

Size Matters



How to Change Your Orbit

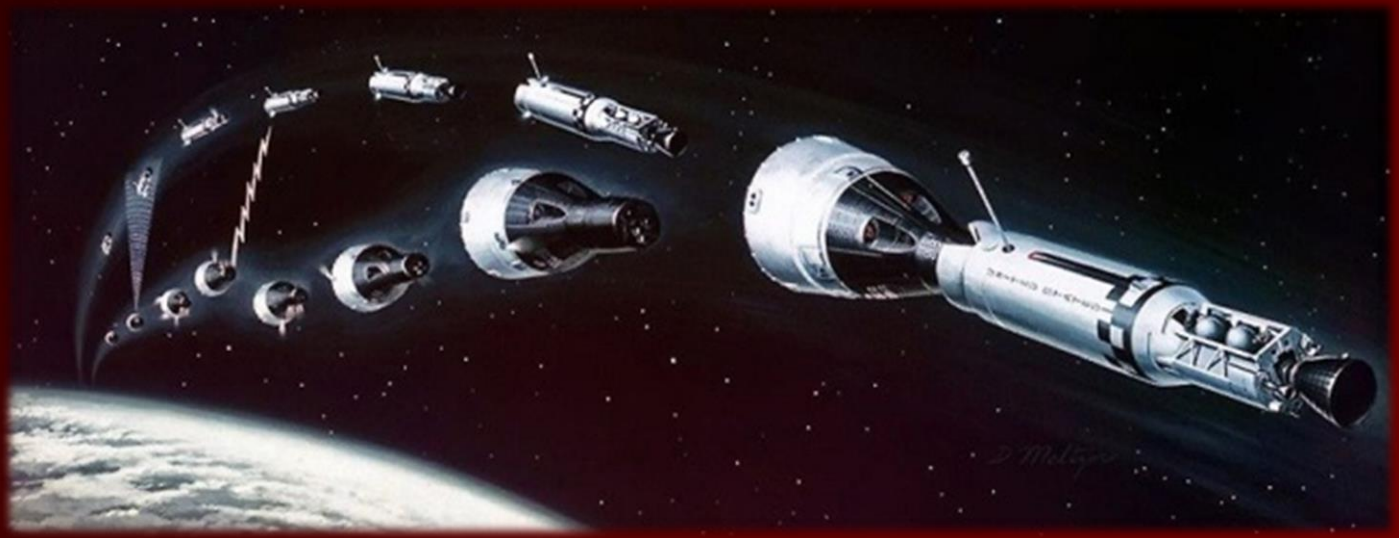




r_a = Apogee (high point)

r_p = Perigee (low point)

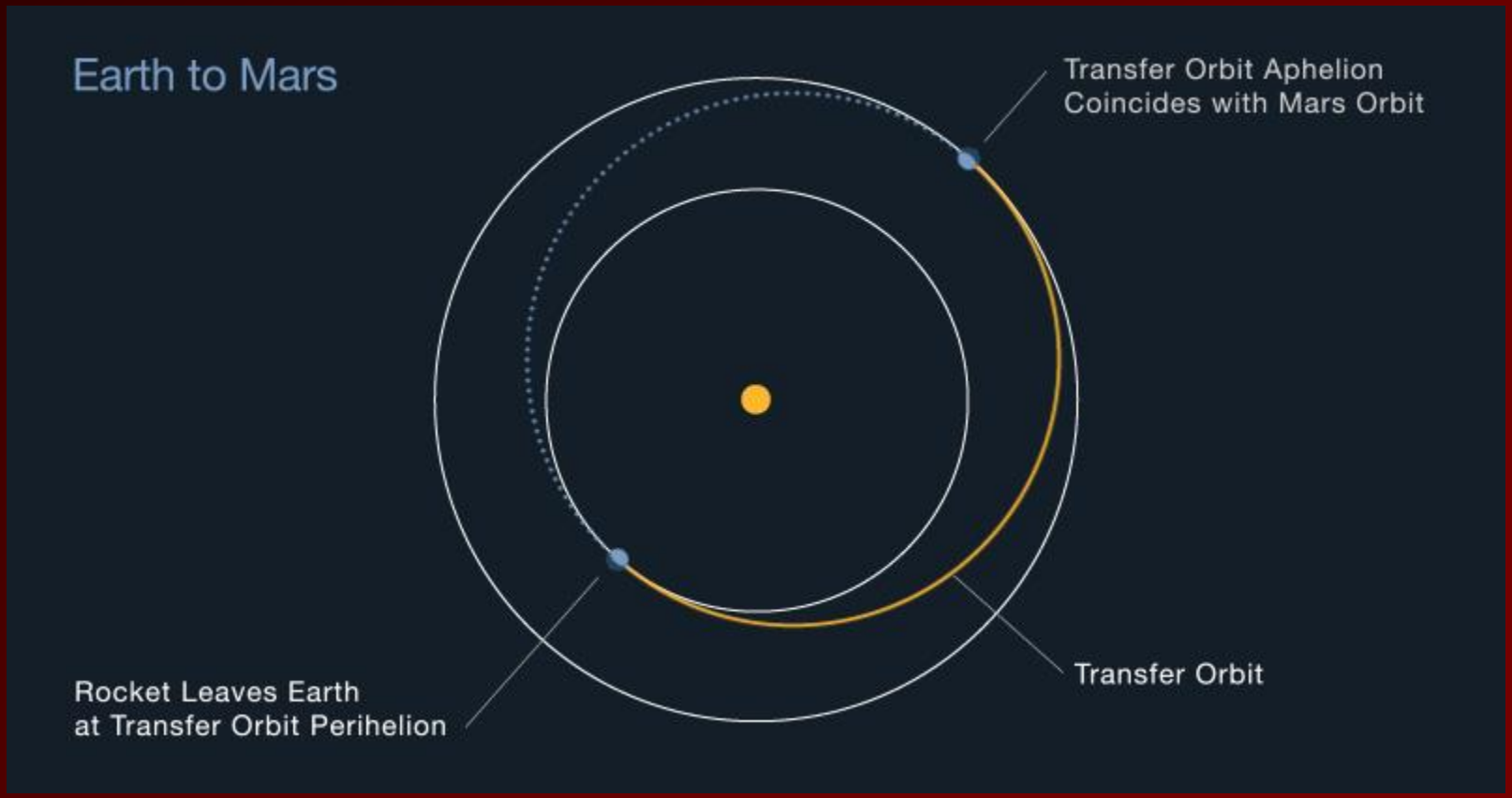
Orbital Paradox



Starship on the Launch Pad

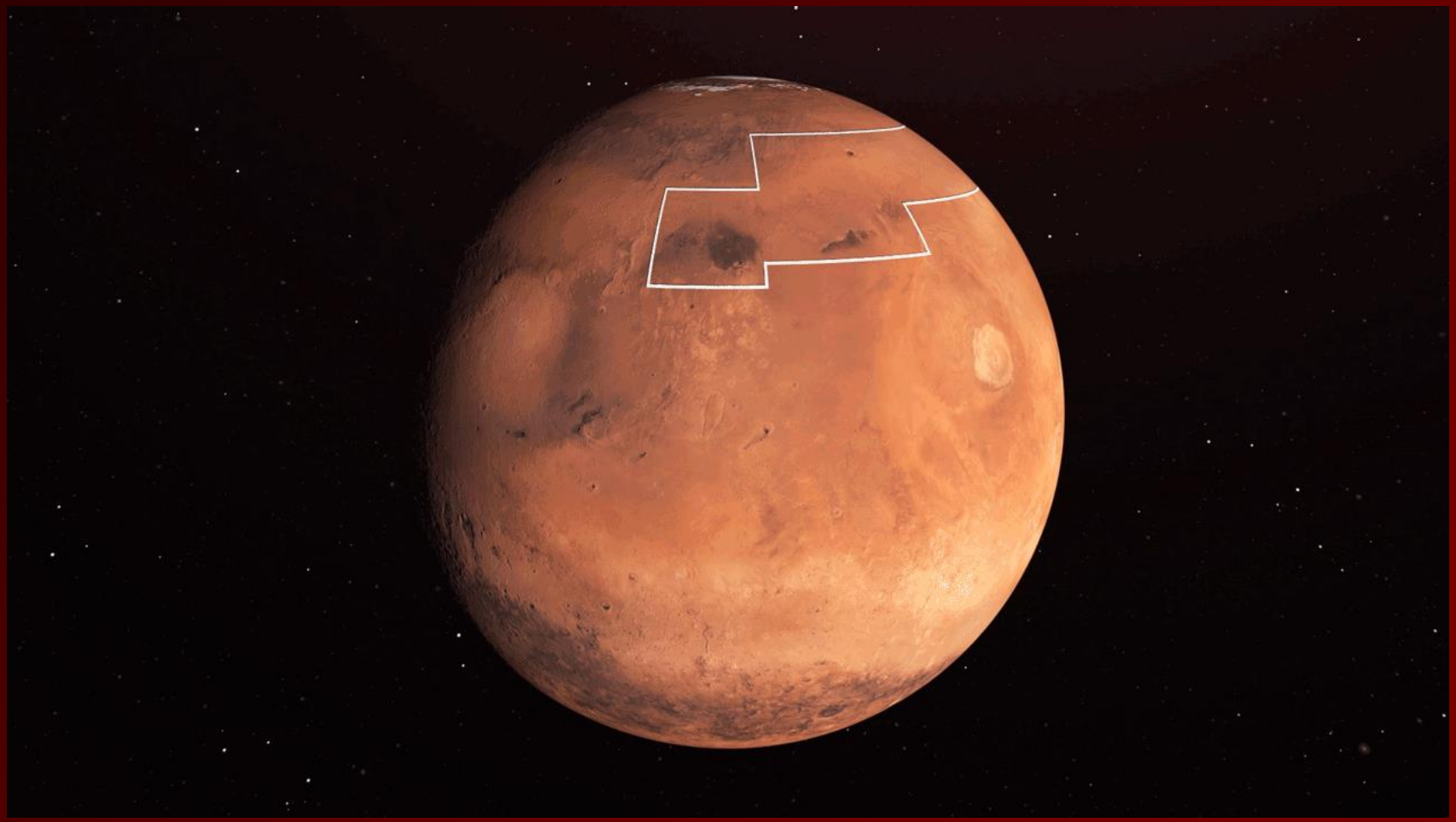
Starship Launch

Mars Transfer Orbit

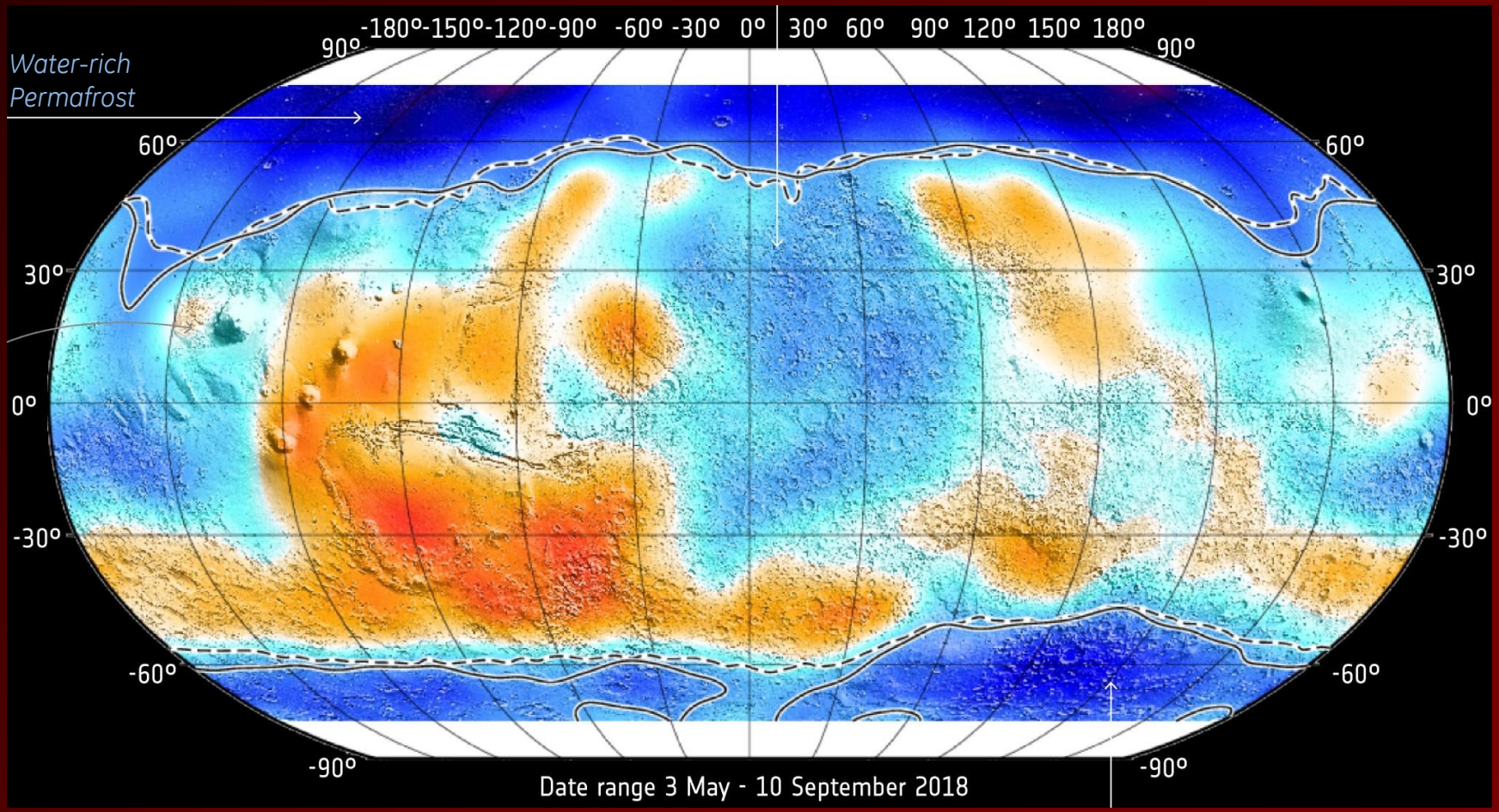


Nine-Month Trip – One Way

Aiming for Water Deposits

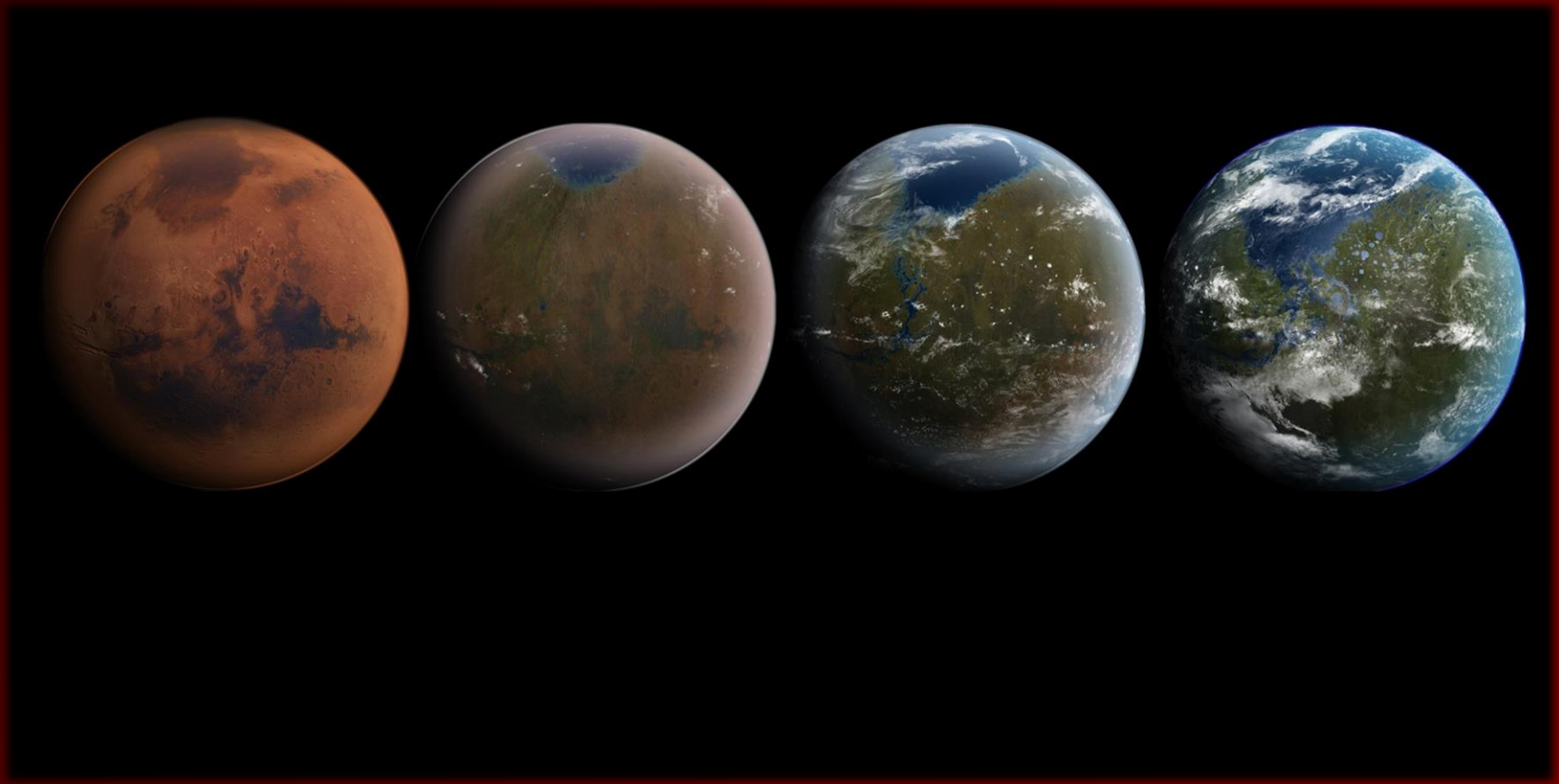


Water Deposits on Mars

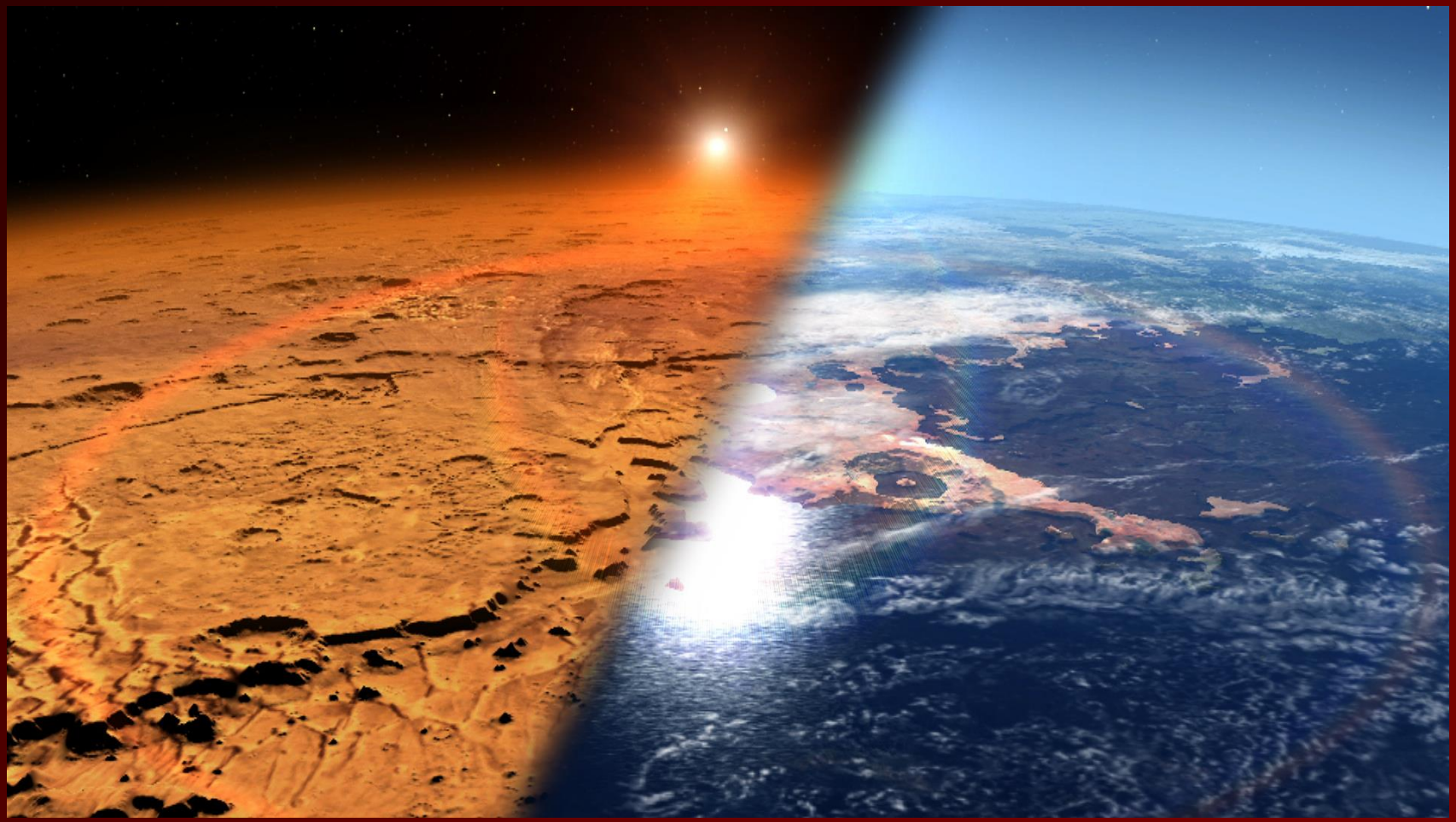


Greenhouse Farms

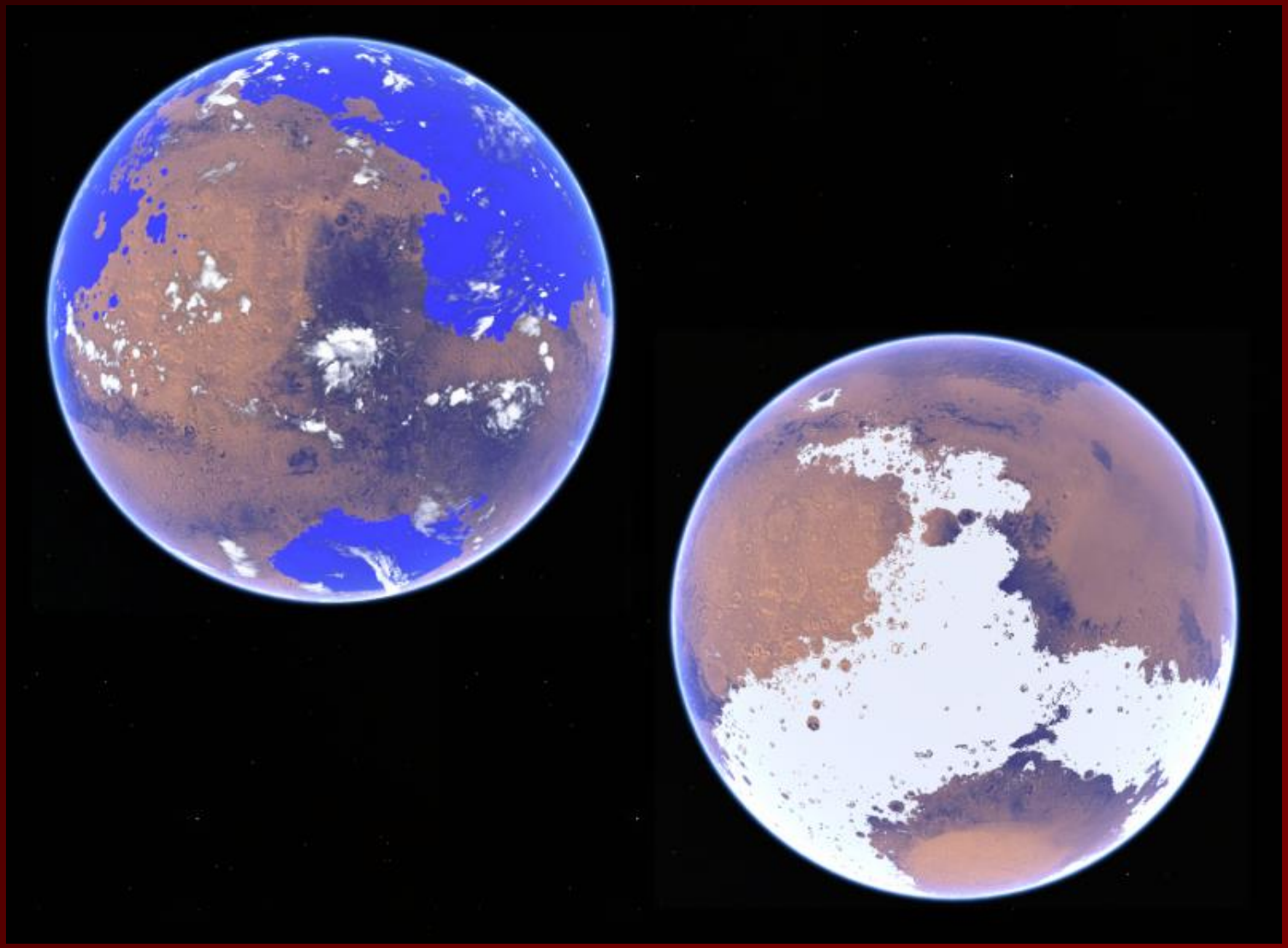
Terraforming Mars



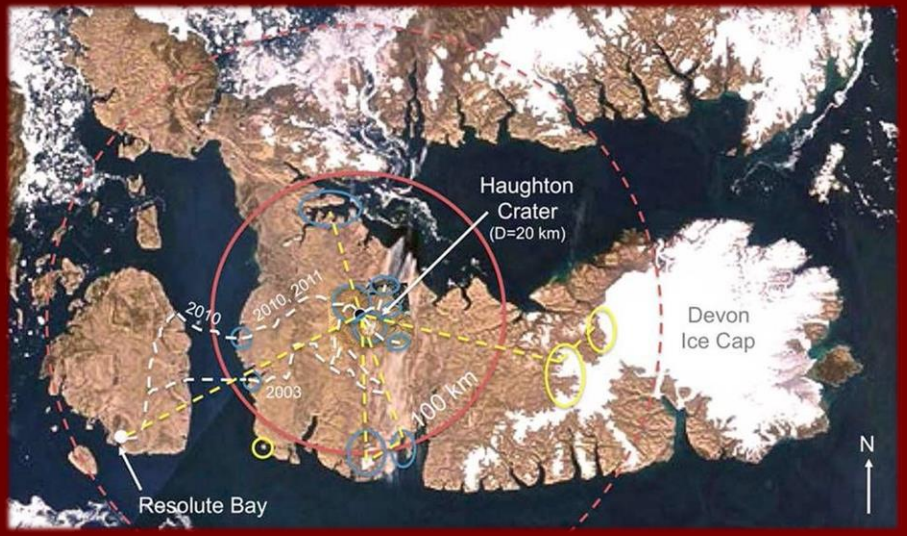
Mars Ocean Hypothesis



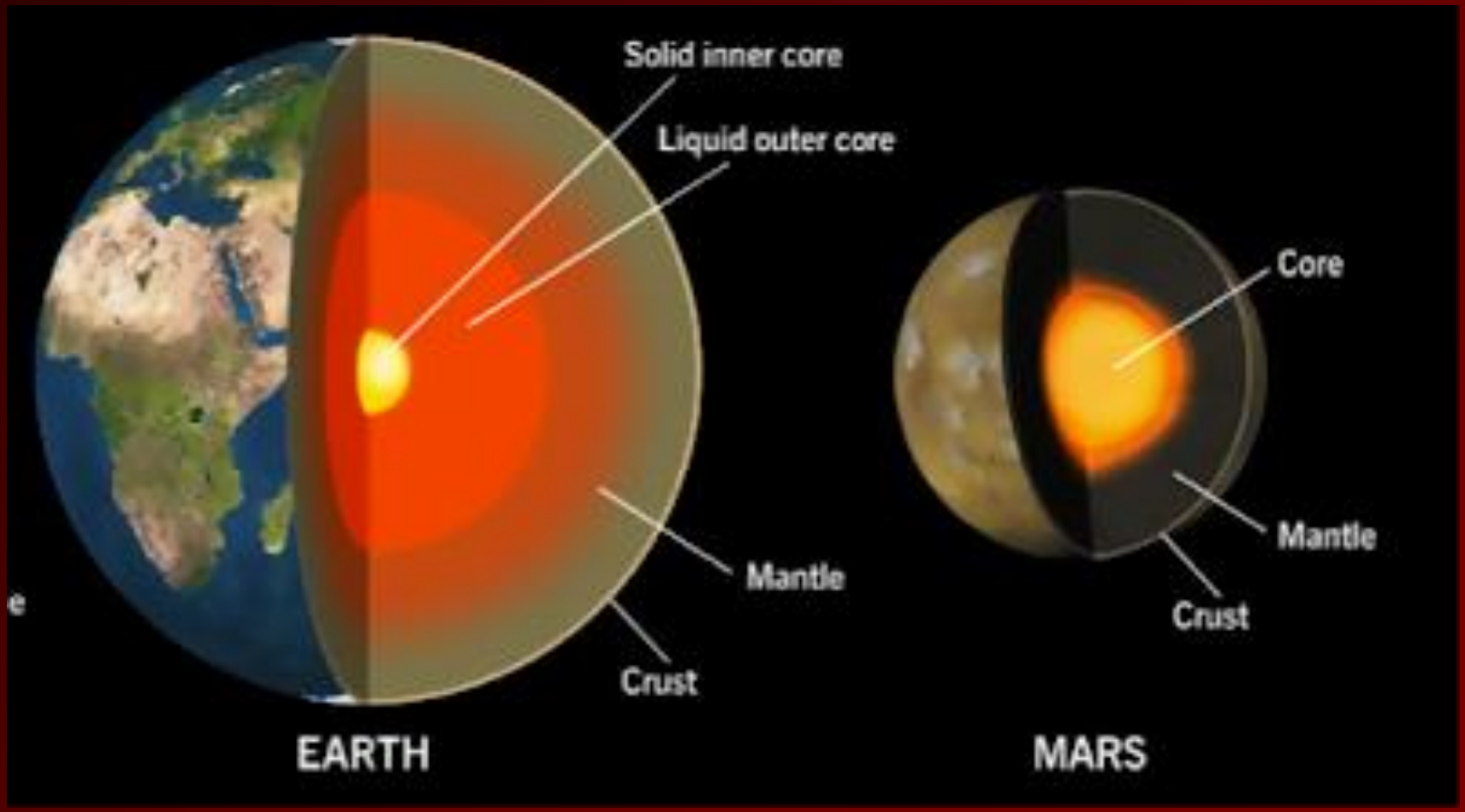
Mars Ice Hypothesis



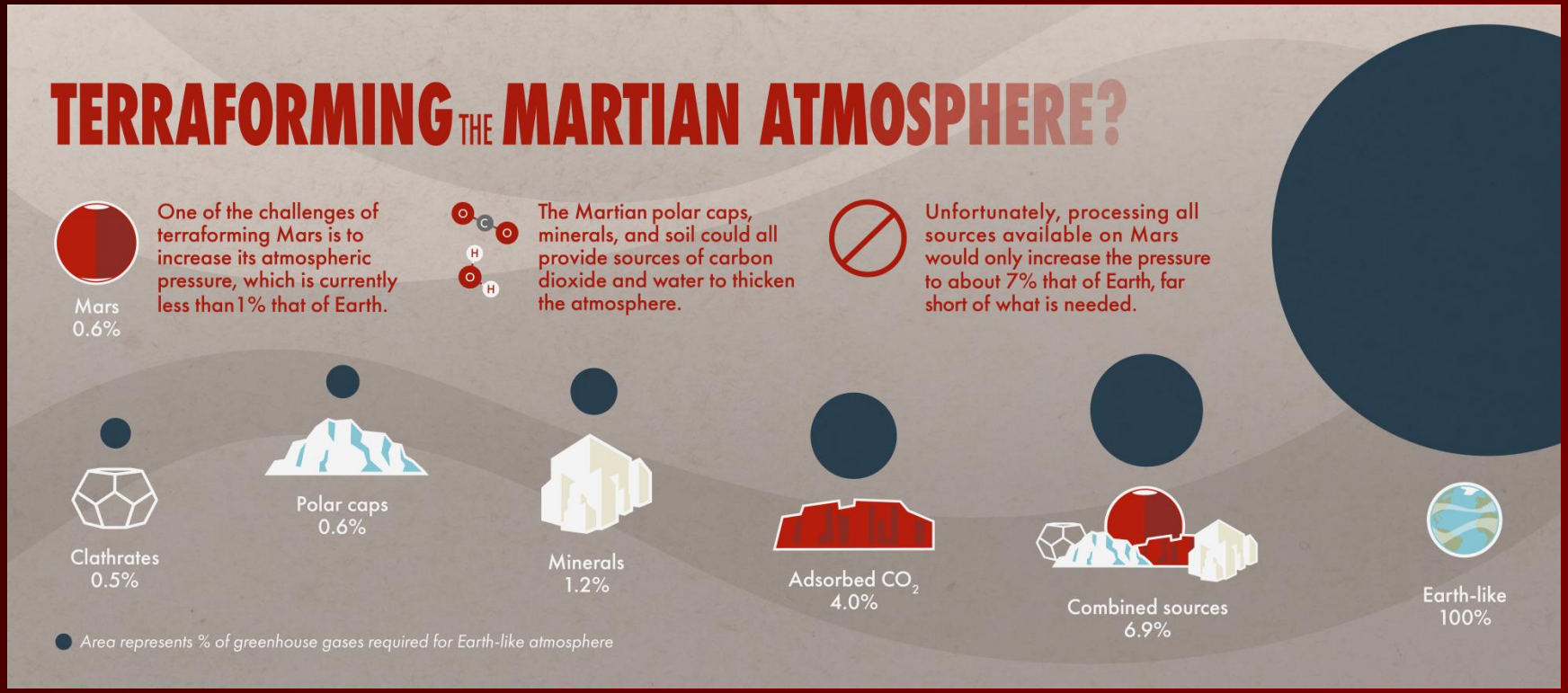
Devon Island, Mars on Earth



Planetary Structure



Resource Limitations



Hazards of a Mars Mission

- Long-term exposure to zero/⅓G gravity
- Radiation (Solar & Cosmic)
- Landing (~50% historical success rate)
- Low atmospheric pressure/lack of O_2
- Dust: contamination, adhesion & toxicity
- Excursions over treacherous terrain
- Isolation & duration: crew dynamics & sanity