

The red planet Mars

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Outline

- History
- Mars 101
- The rovers
- Water
- DRM
- Mars on Earth

History

- Nergal – Ares ♂ - Mars
- Schiaparelli 1877
- Lowell 1895
- War of the Worlds 1938

THE
WAR
OF THE
WORLDS

Marsnik 1 (Mars 1960A) - 10 October 1960 - Flyby (launch failure)
Marsnik 2 (Mars 1960B) - 14 October 1960 - Flyby (launch failure)
Sputnik 22 - 24 October 1962 - Flyby (failure after launch)
Mars 1 - 1 November 1962 - Fly by (lost contact)
Sputnik 24 - 4 November 1962 - Lander (failure after launch)
Mariner 3 - 5 November 1964 - Flyby (failure after launch)
Mariner 4 - 28 November 1964 - Flyby
Zond 2 - 30 November 1964 - Flyby (contact lost)
Zond 3 - 18 July 1965 - Flyby of the Moon (missed launch window for Mars)
Mariner 6 - 25 February 1969 - Flyby
Mariner 7 - 27 Mars 1969 - Flyby
Mars 1969A - 27 Mars 1969 - Satellite (launch failure)
Mars 1969B - 2 April 1969 - Satellite (launch failure)
Mariner 8 - 8 May 1971 - Satellite (launch failure)
Kosmos 419 - 10 May 1971 - Satellite (launch failure)
Mars 2 - 19 May 1971 - Satellite/lander (lost on the surface of Mars)
Mars 3 - 28 May 1971 - Satellite/lander
Mariner 9 - 30 May 1971 - Satellite
Mars 4 - 21 July 1973 - Satellite -> Flyby
Mars 5 - 25 July 1973 - Satellite
Mars 6 - 5 August 1973 - Lander (contact lost)
Mars 7 - 9 August 1973 - Lander -> Flyby (hard ware malfunction)
Viking 1 - 20 August 1975 - Satellite/lander
Viking 2 - 9 September 1975 - Satellite/lander
Phobos 1 - 7 July 1988 - Satellite/Phobos-Lander (program error)
Phobos 2 - 12 July 1988 - Satellite/Phobos-lander (contact lost)
Mars Observer - 25 September 1992 - Satellite (contact lost)
Mars Global Surveyor - 07 November 1996 - Satellite
Mars 96 - 16 November 1996 - Satellite/lander/penetrators (launch failure)
Mars Pathfinder - 04 December 1996 - Lander/rover
Nozomi - 3 July 1998 - Satellite (valve malfunction)
Mars Climate Orbiter - 11 December 1998 - Satellite (program error)
Mars Polar Lander - 3 January 1999 - Lander (contact lost)
Deep Space 2 - 3 January 1999 - Penetrators (contact lost)
Mars Odyssey - 7 April 2001 - Satellite
Mars Express - 2 June 2003 - Satellite/lander (contact lost)
Spirit (MER-A) - 10 June 2003 - Rover
Opportunity (MER-B) - 7 July 2003 - Rover
Mars Reconnaissance Orbiter - 15 August 2005 - Satellite
Phoenix - 4 August 2007 - Lander
Fobos-Grunt - 8 November 2011 - Satellite/lander (Com & control failure)
Curiosity - 26 November 2011 - Lander
Mars Orbiter Mission - 5 November 2013 - Satellite
Maven - 18 November 2013 - Satellite

Mars 101



Distance to Mars

- From Earth:
 - Minimum 55 million km
 - Maximum 400 million km
- From the Sun:
 - 1.5 AU $\approx$ 230 million km



SUN

MERCURY

VENUS

EARTH

MARS

JUPITER

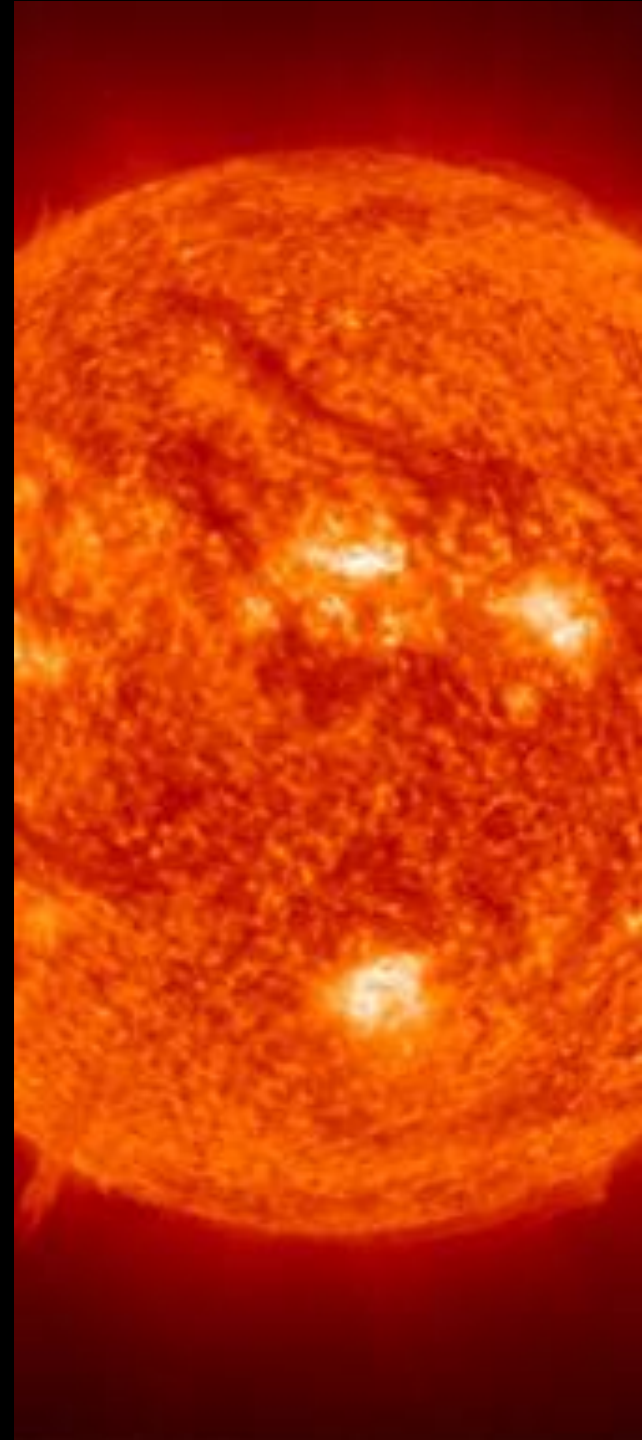
SATURN

URANUS

NEPTUNE

Solar irradiance

- Mars: 590 W/m²
- Jorden: 1370 W/m²



Orbital parameters

- Axial tilt: 25.2°
- Eccentricity: 0.09
- Solar rotation period: 24 h 39 min
- Orbital period: 669 SOL, 687 Earth days

Size

- Mars:

- Radius: 3390 km
- Mass: 0.6×10^{24} kg
- Gravity: 3.7 m/s^2

- Earth:

- Radius: 6371 km
- Mass: 6×10^{24} kg



The Red Planet



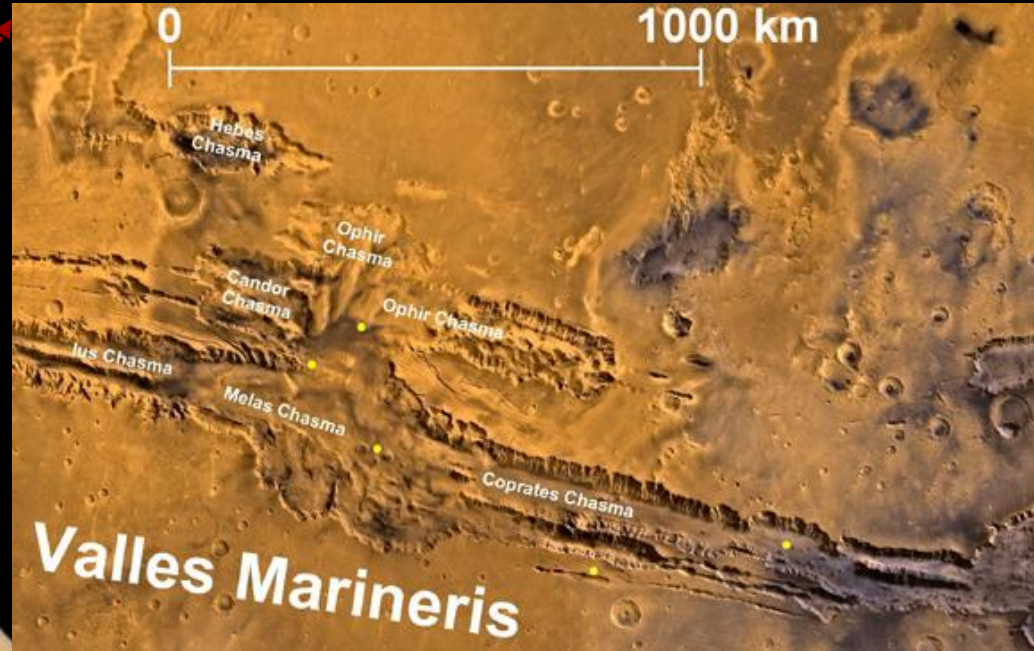
Olympus Mons

- 27 km high
- 600 km at the base



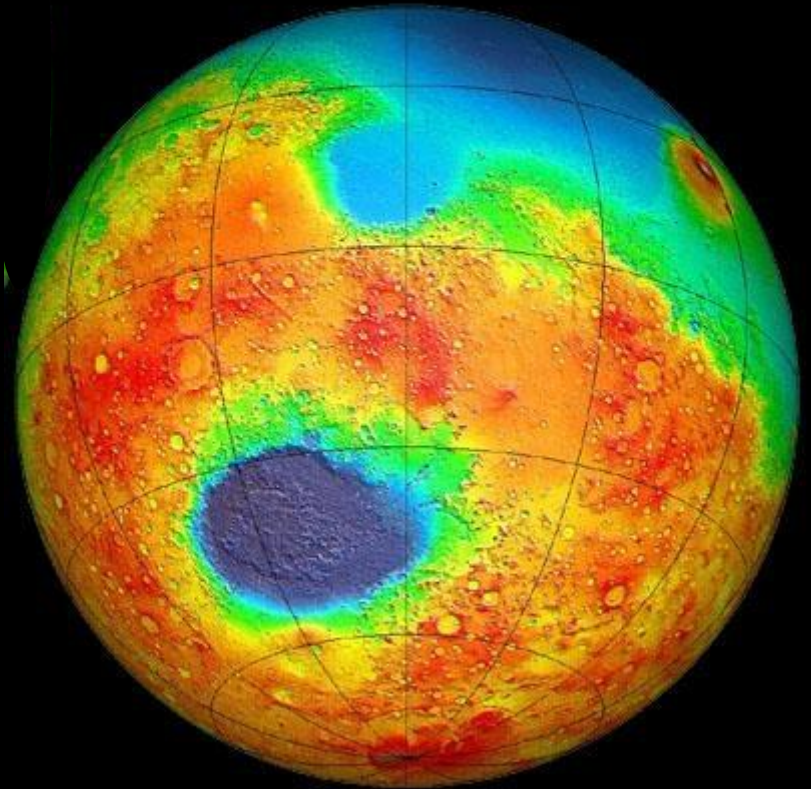
Valles Marineris

- Canyon
 - 4000 km long
 - 2-7 km deep



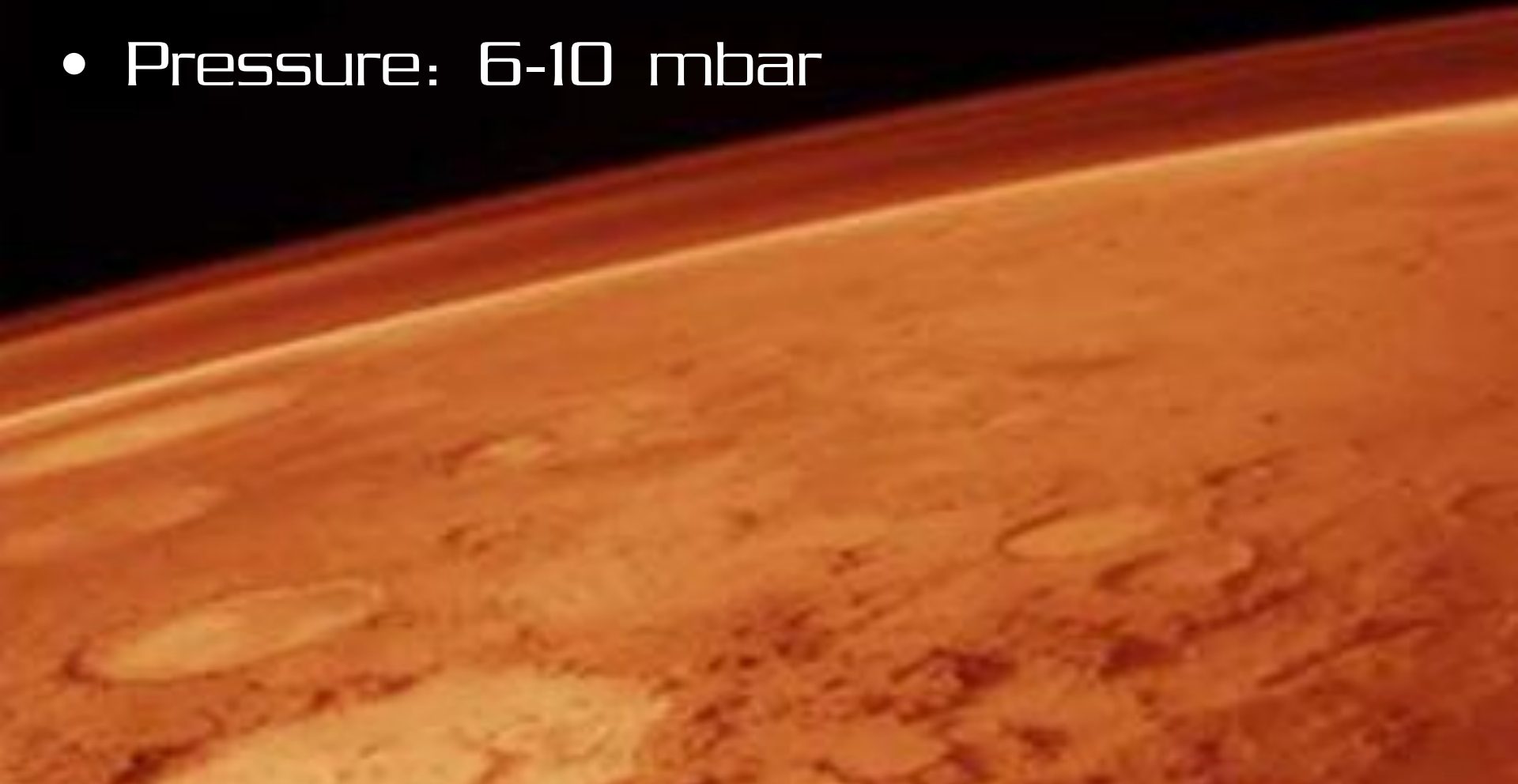
Hellas Planitia

- Impact crater
 - 2000 km wide
 - 7 km deep



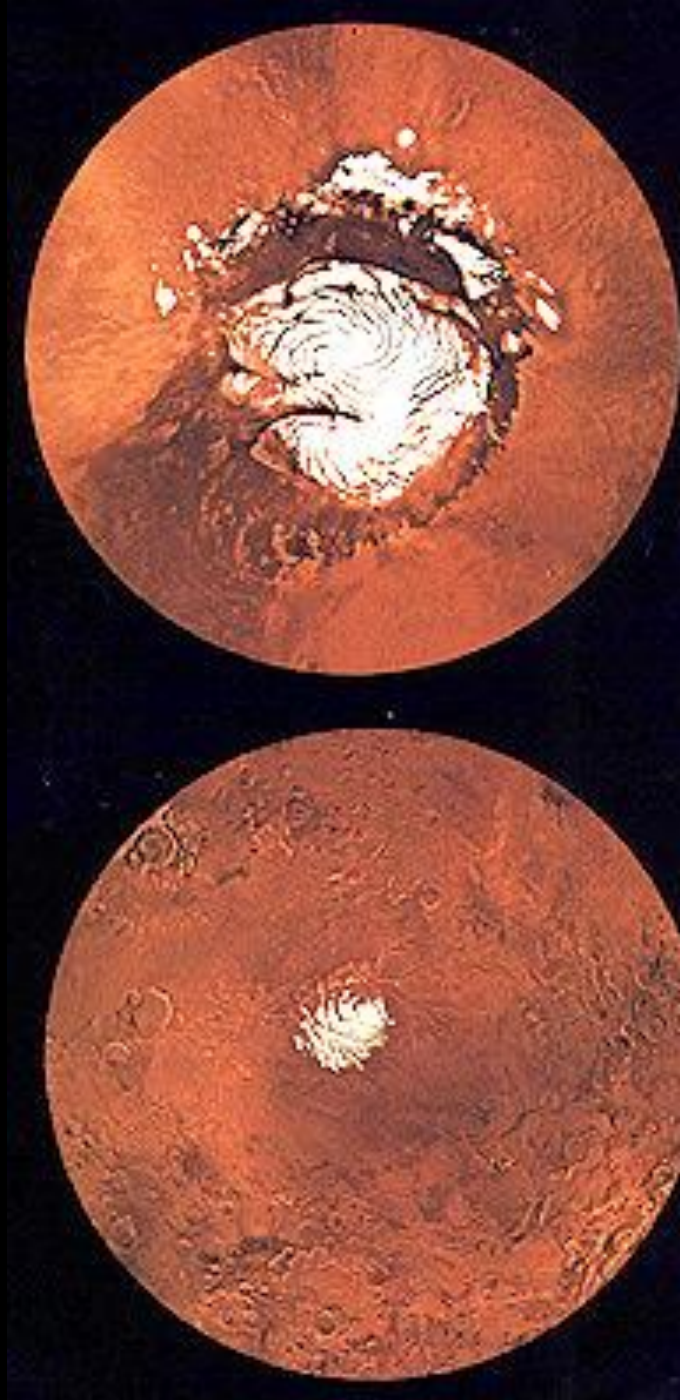
Atmosphere

- Composition: 95% CO₂
- Pressure: 6-10 mbar



Polarcaps

- Residual/seasonal
- Polar ice composition:
 - Water
 - Carbondioxide



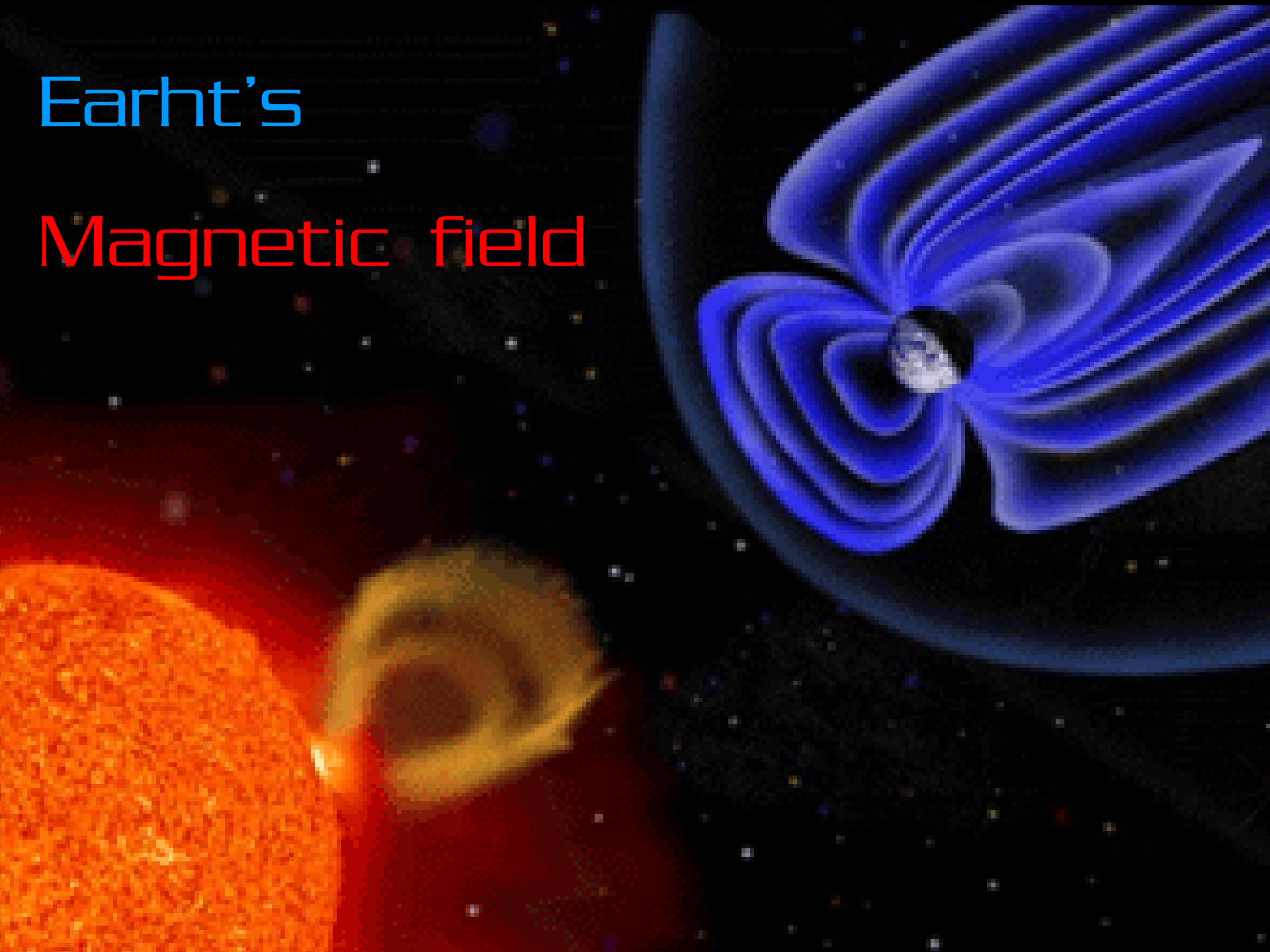
Climate

- Mean temperature: $-55\text{ }^{\circ}\text{C}$
 - Min: $-140\text{ }^{\circ}\text{C}$
 - Max: $+20\text{ }^{\circ}\text{C}$

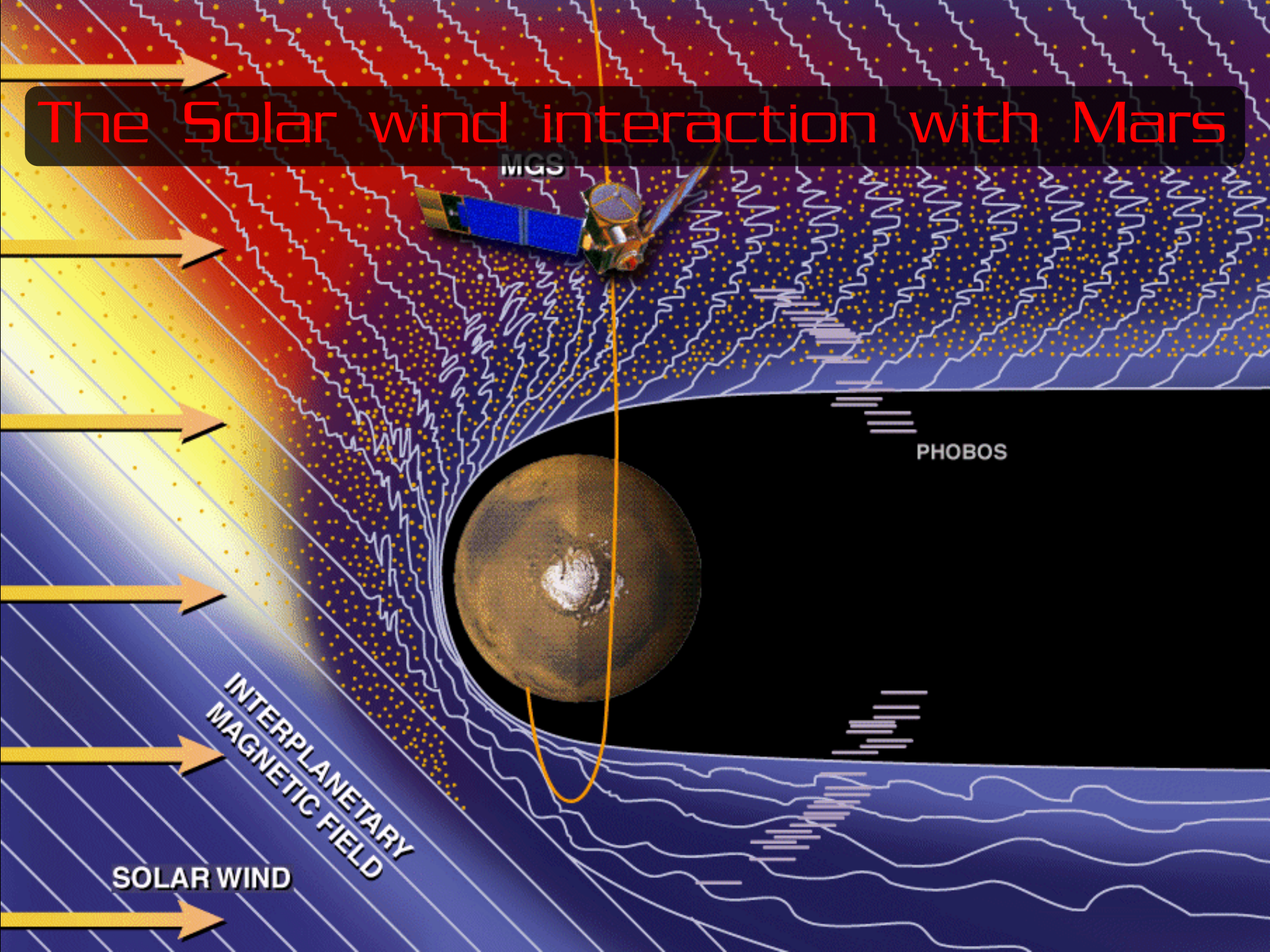


Earth's

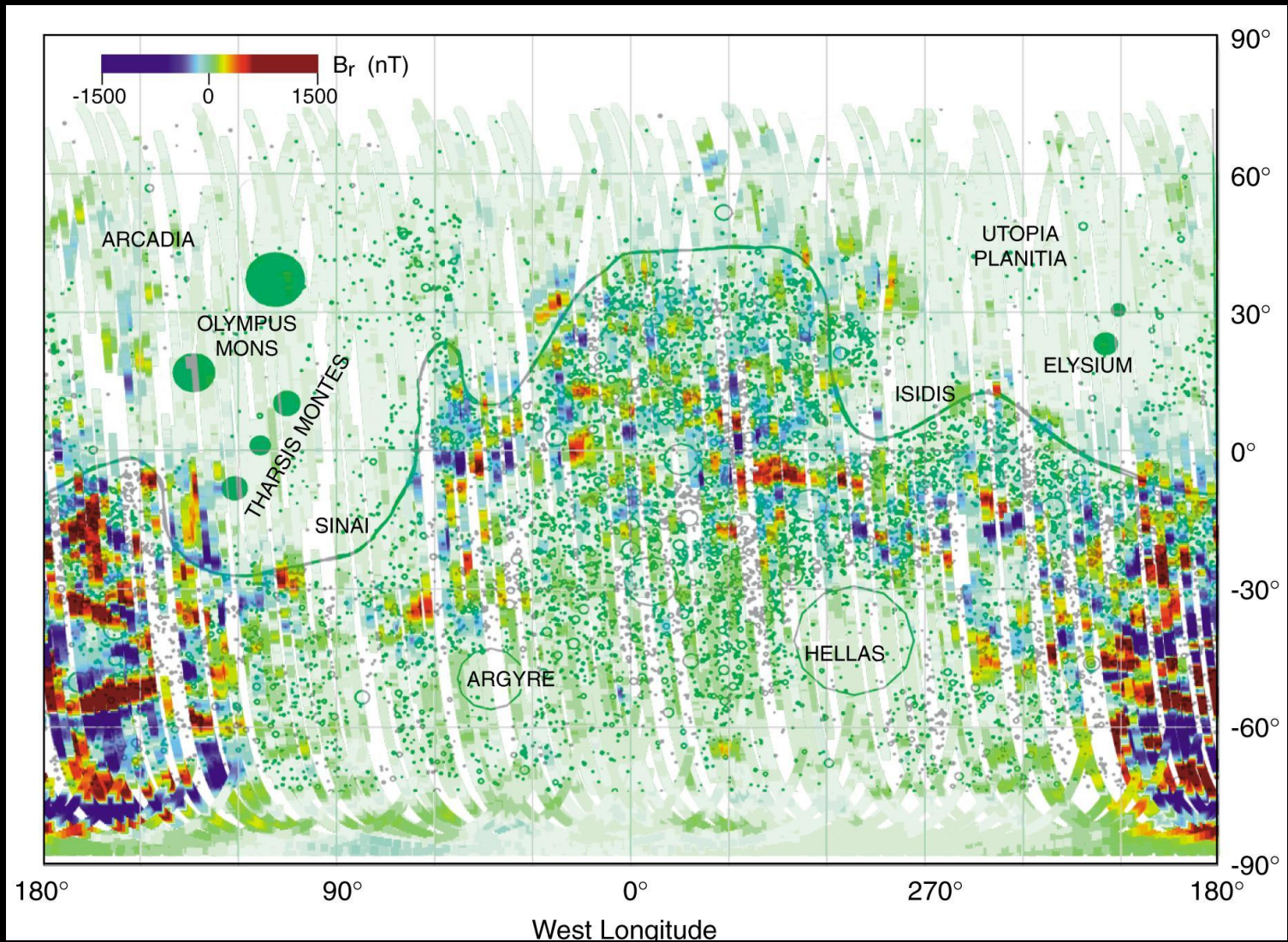
Magnetic field



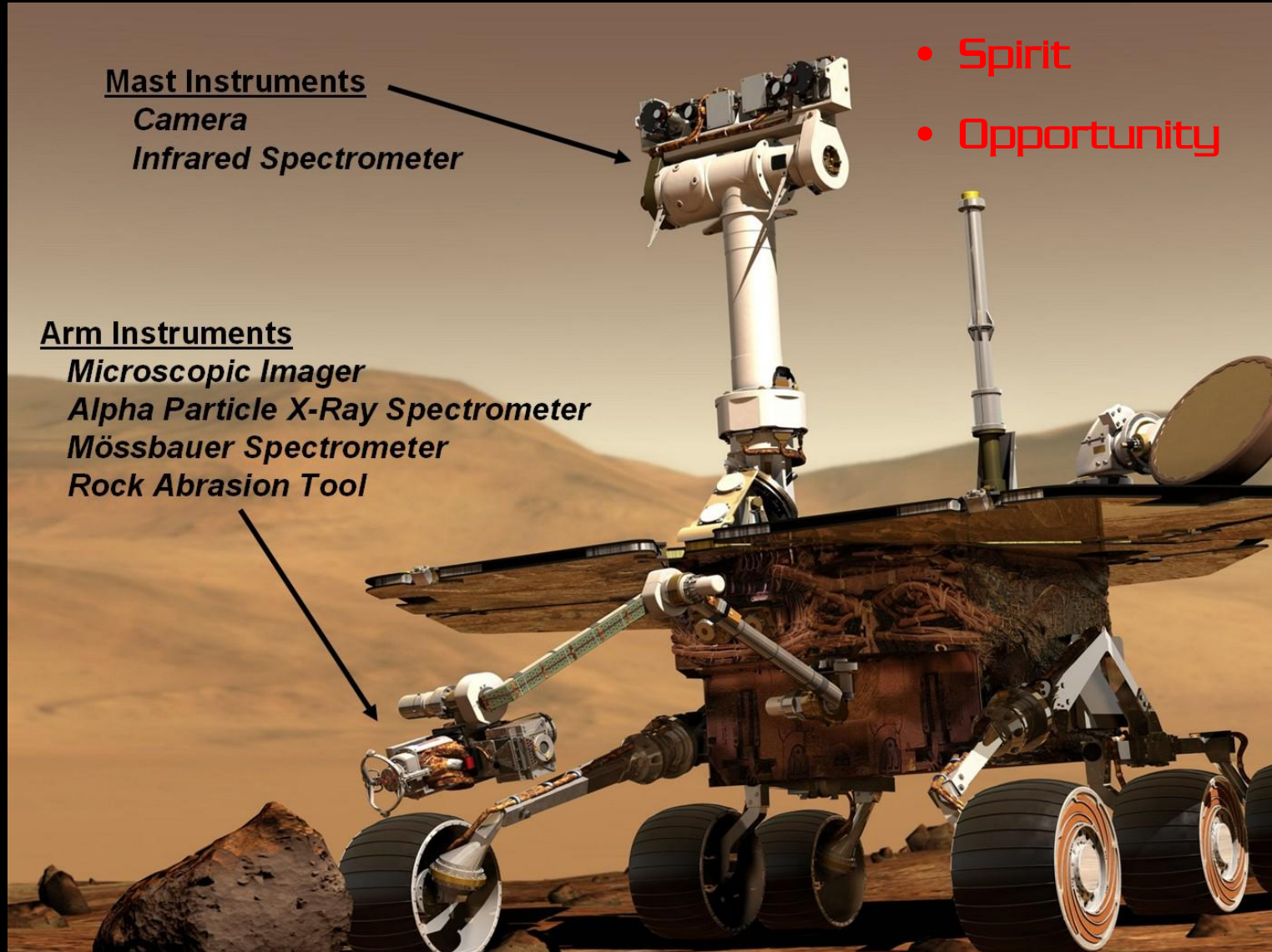
The Solar wind interaction with Mars



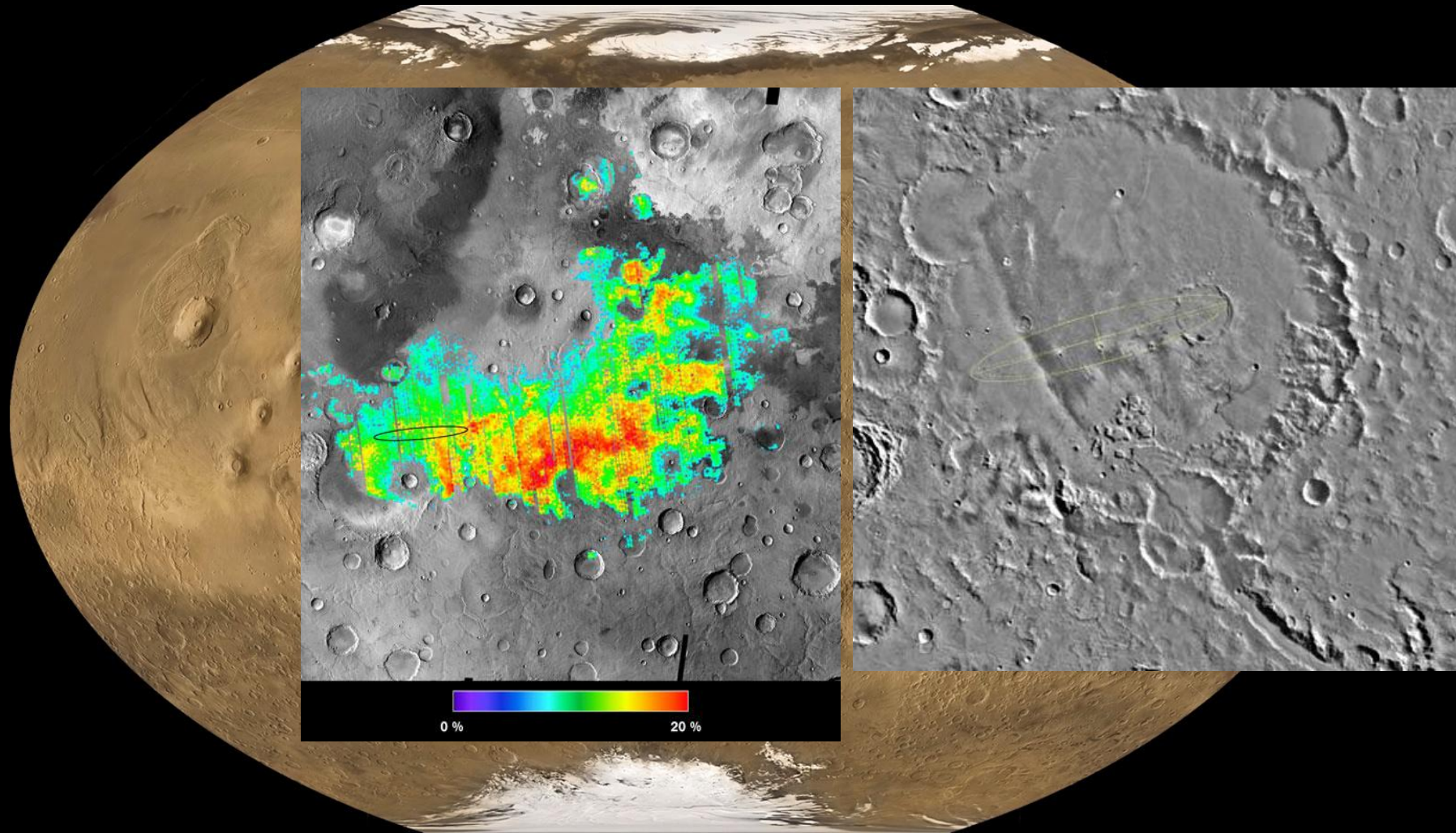
Magnetic anomalies



Mars Exploration Rovers



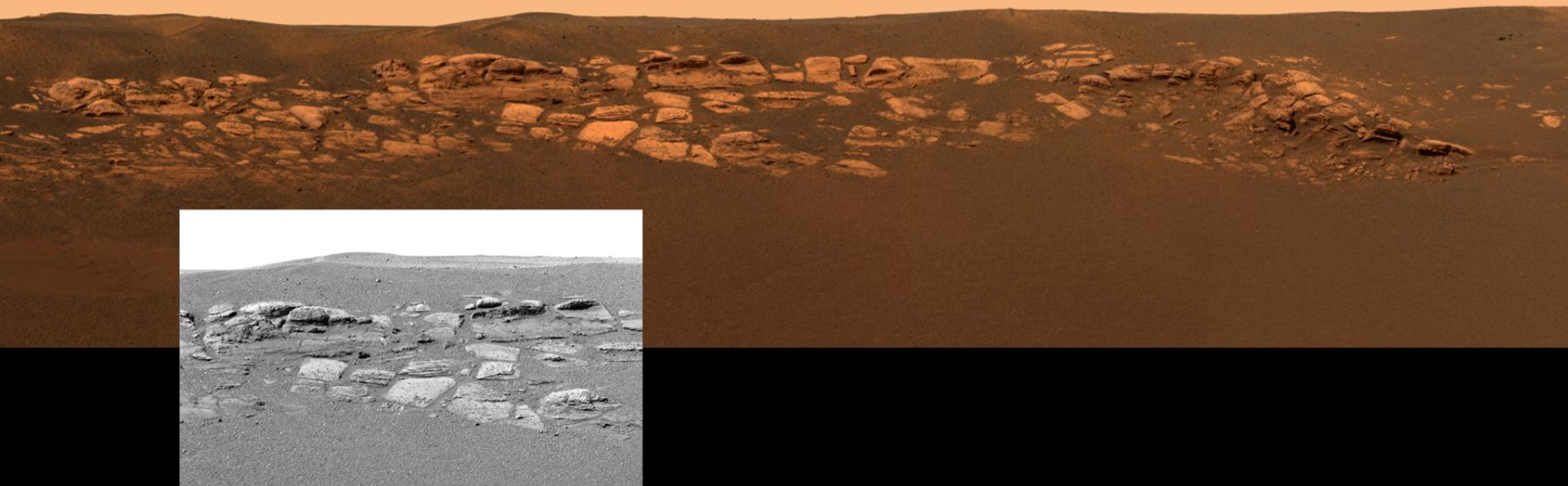
MER – landing sites



Spirit view of the East Hill Complex at Gusev Crater



Opportunity view of layered rock outcrop at Meridiani Planum



Dust



Dust

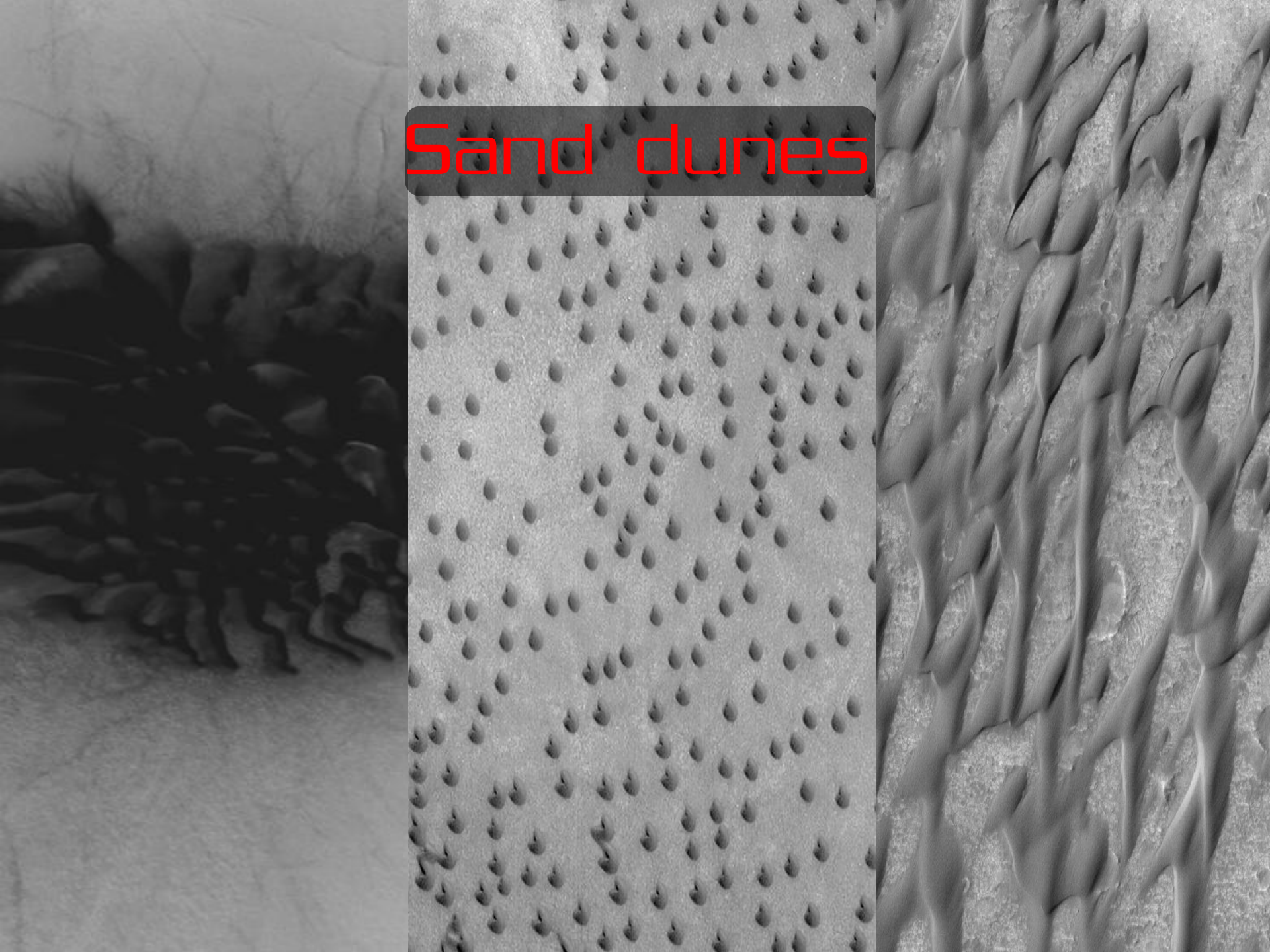
June 10, 2001



July 31, 2001



Sand dunes



Water

Water

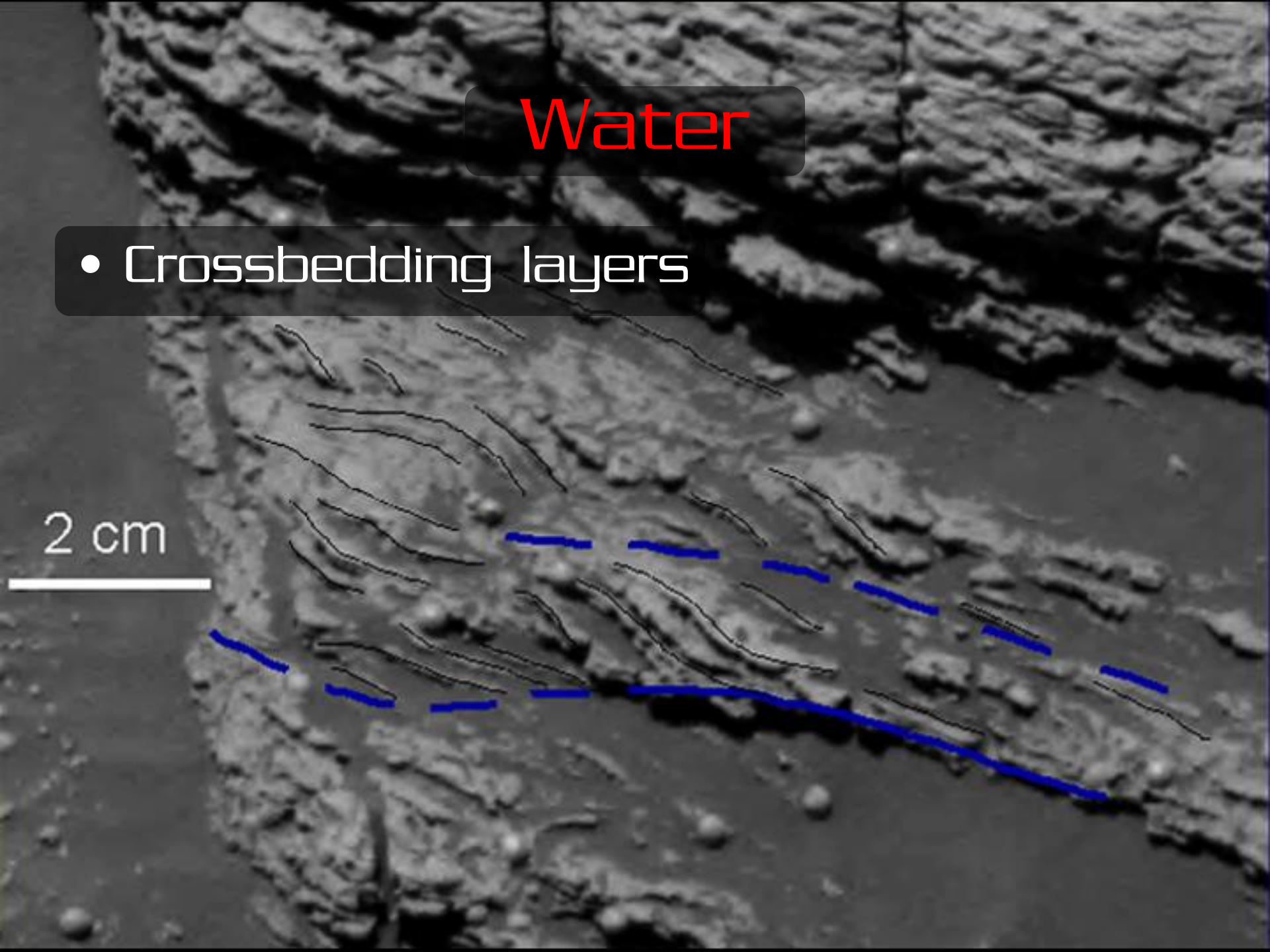
- Salt layers

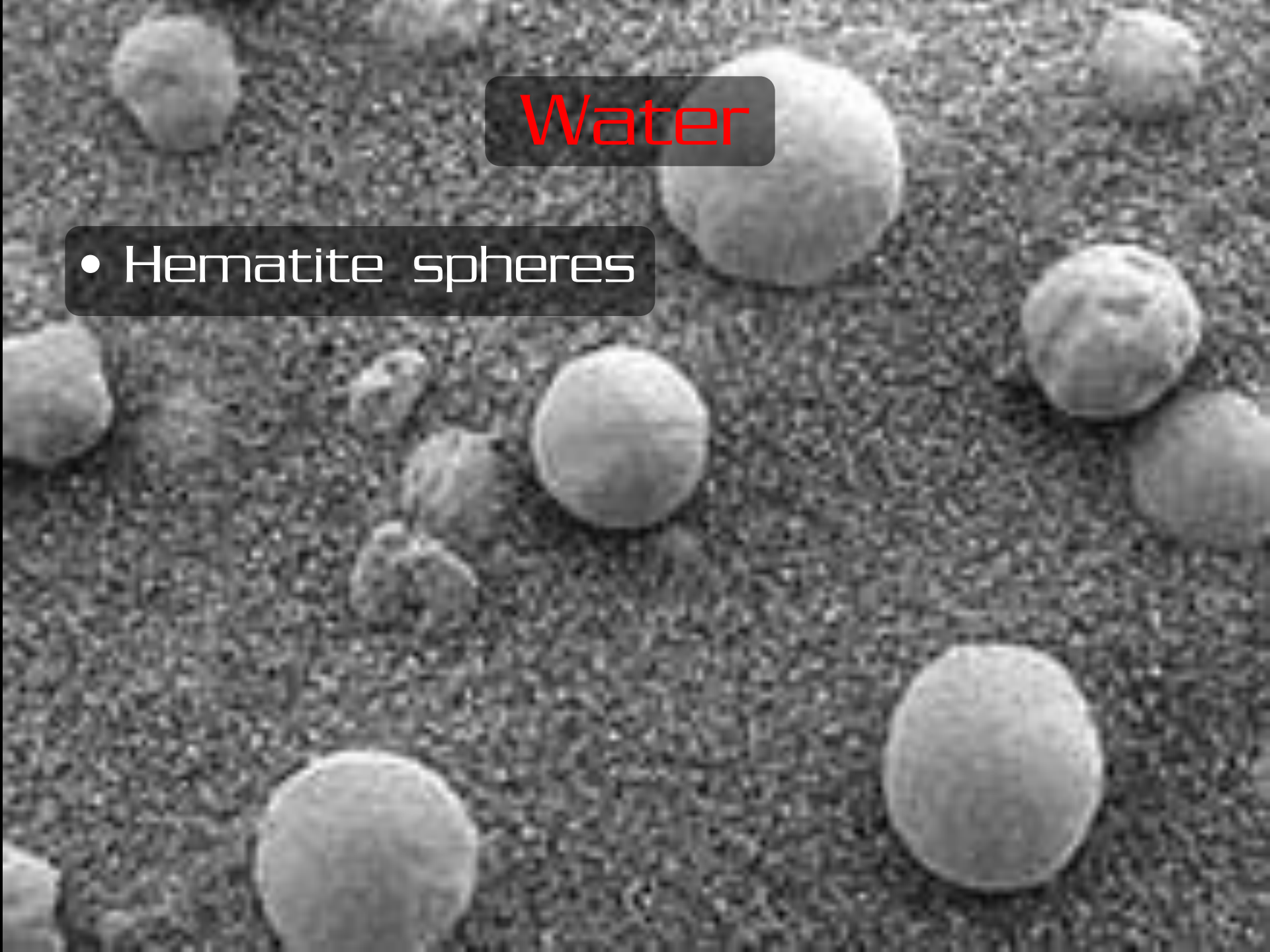


Water

- Crossbedding layers

2 cm



A scanning electron micrograph (SEM) showing numerous spherical particles of varying sizes. The spheres are light gray and have a slightly textured surface, contrasting with the darker, granular background. They are distributed across the field of view, with some appearing in sharp focus and others slightly blurred in the background.

Water

- Hematite spheres

Water

- River systems?



Water

- Eye formations



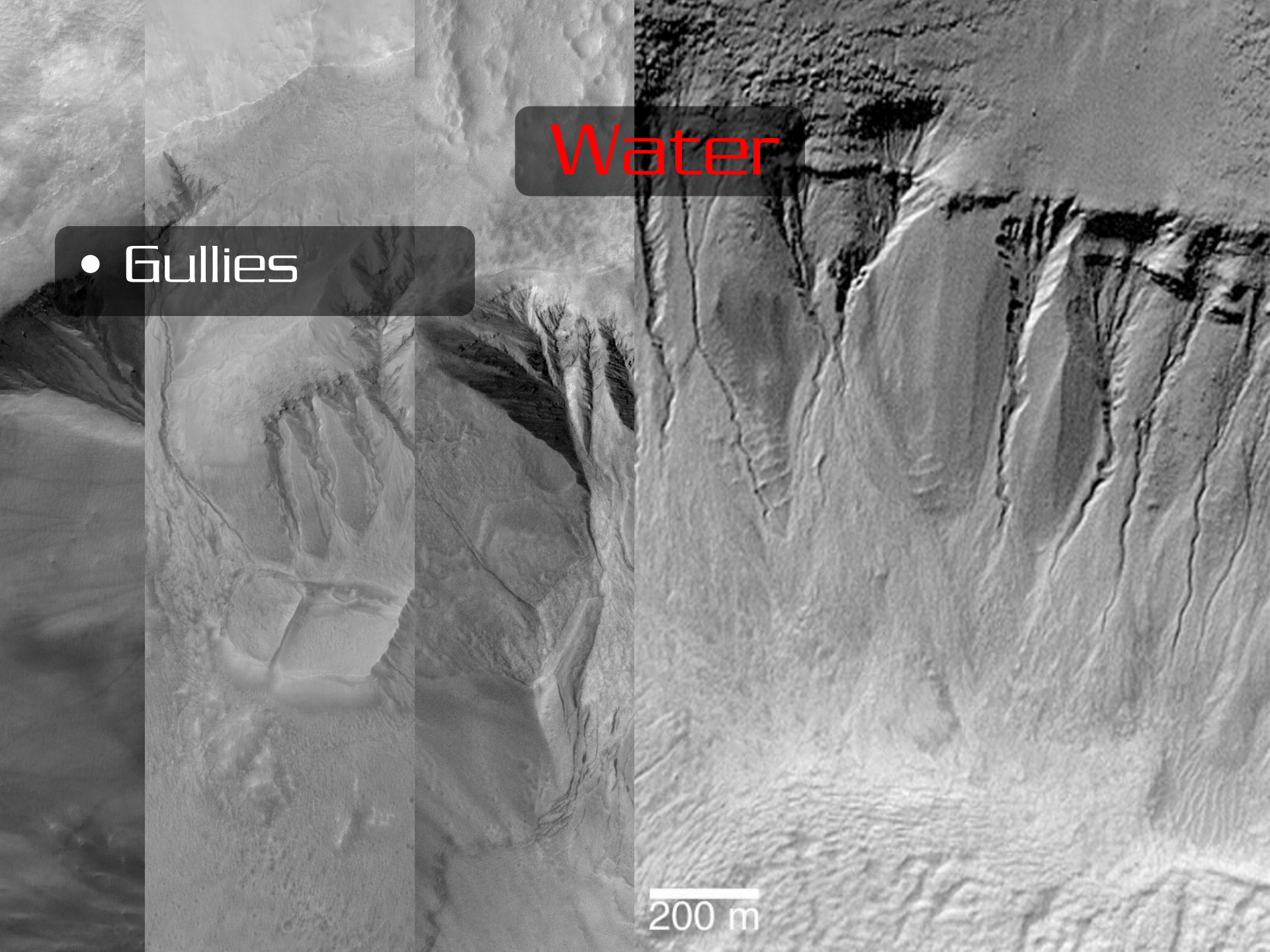
Water

- Ancient riverbed?

Water

- A frozen lake?

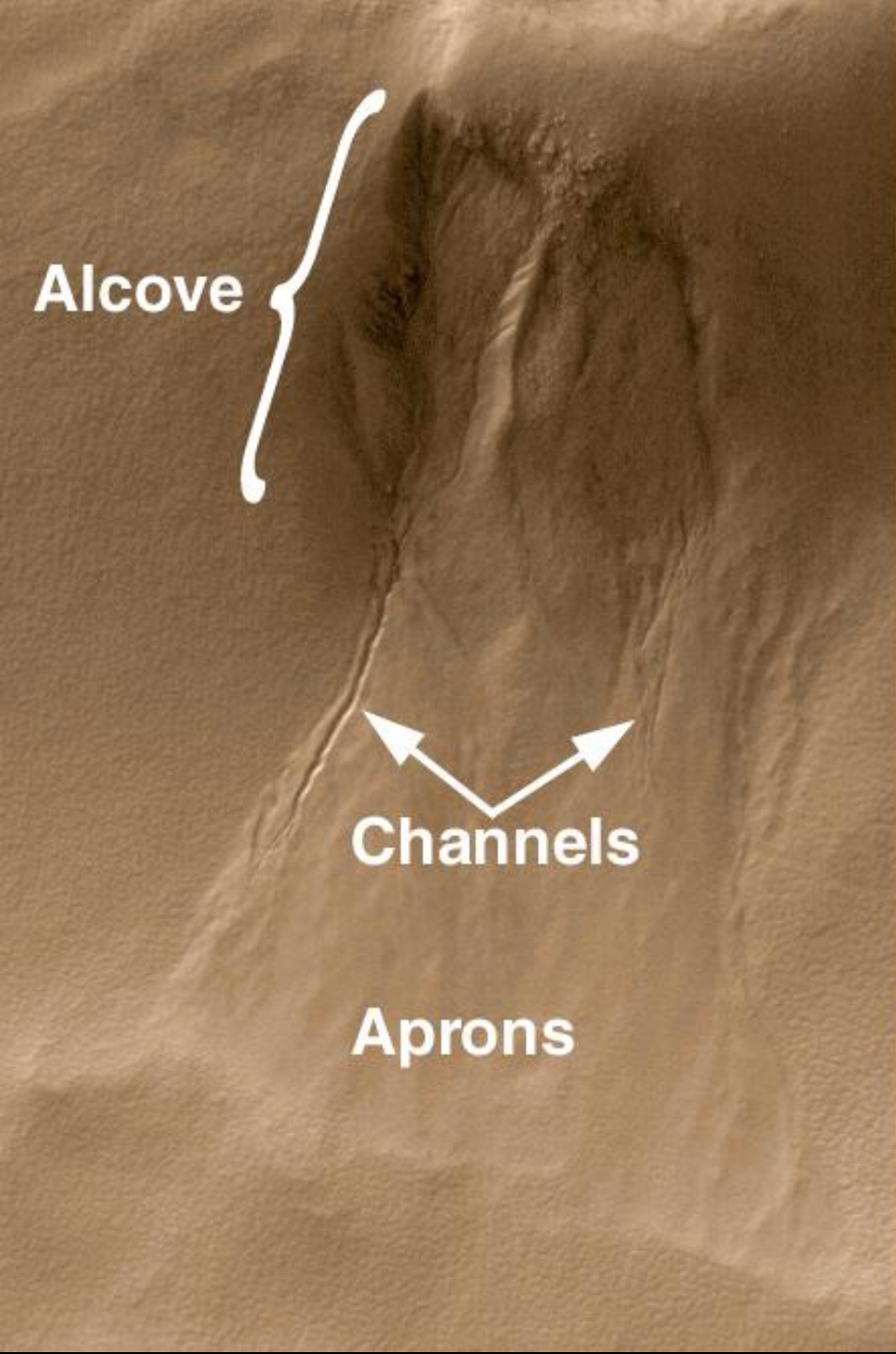




Water

- Gullies

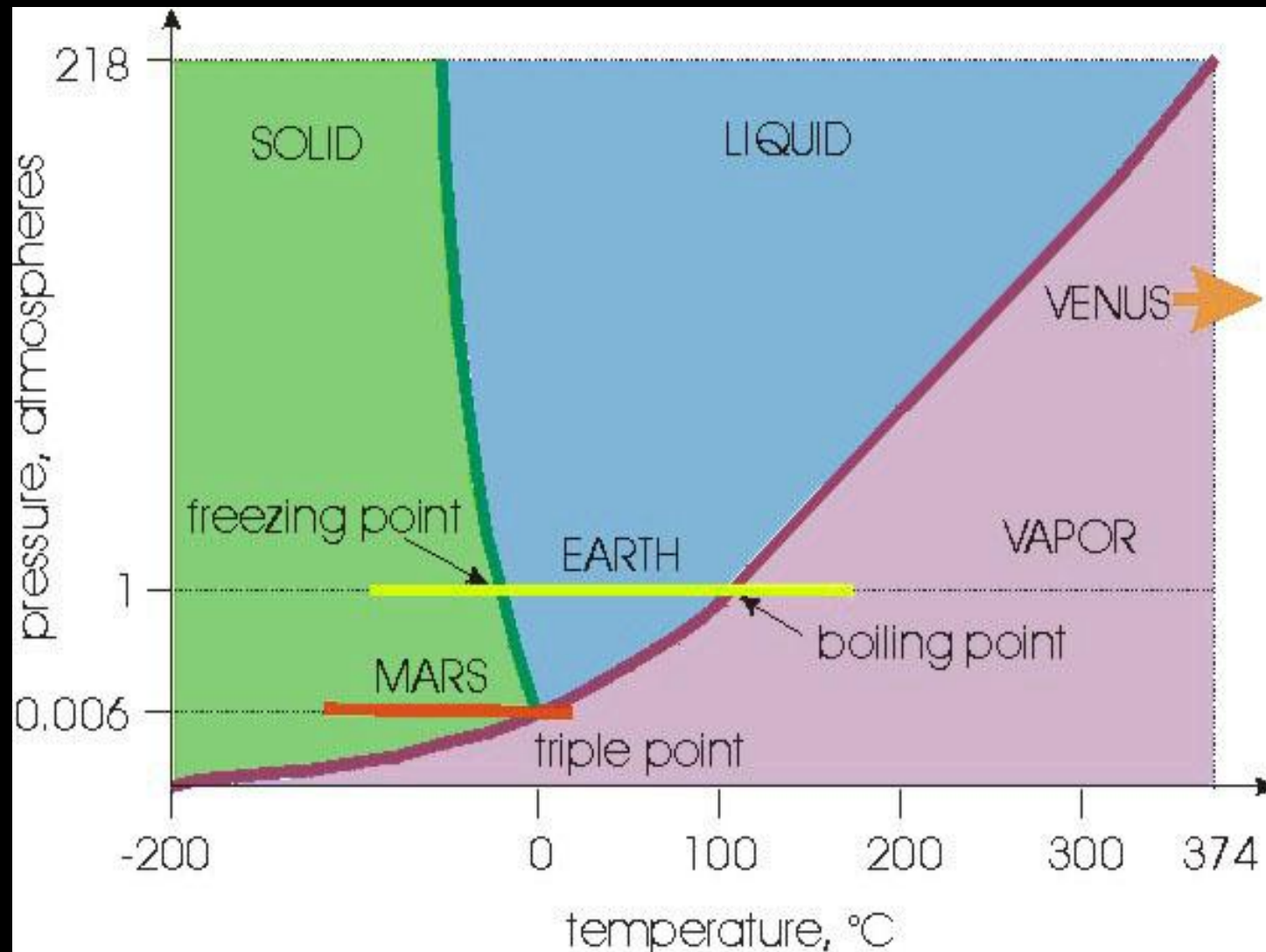
200 m







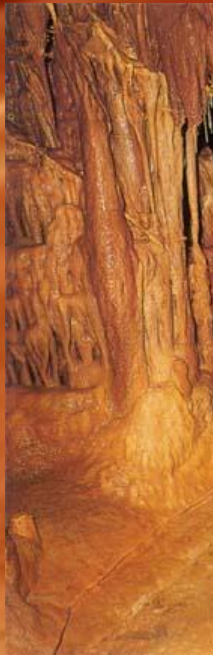
Phase diagram for water

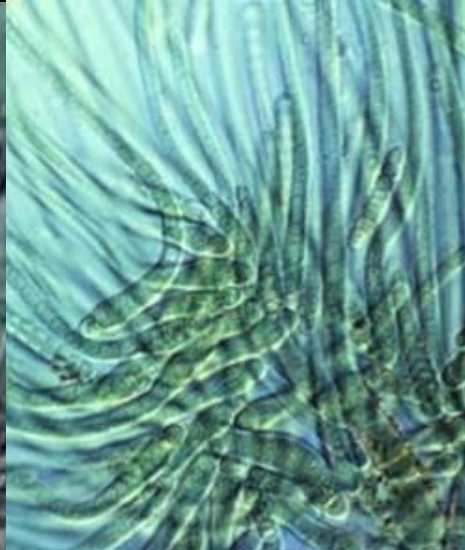


Water $\Rightarrow$ Life?

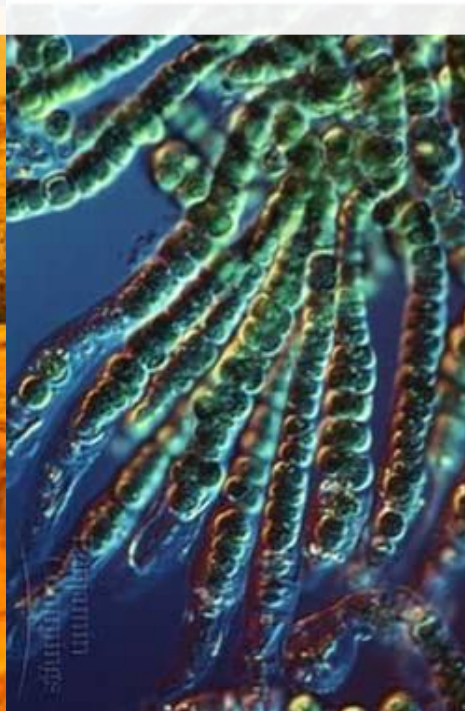


Life in extreme environments





Extremophiles?



A manned mission to Mars

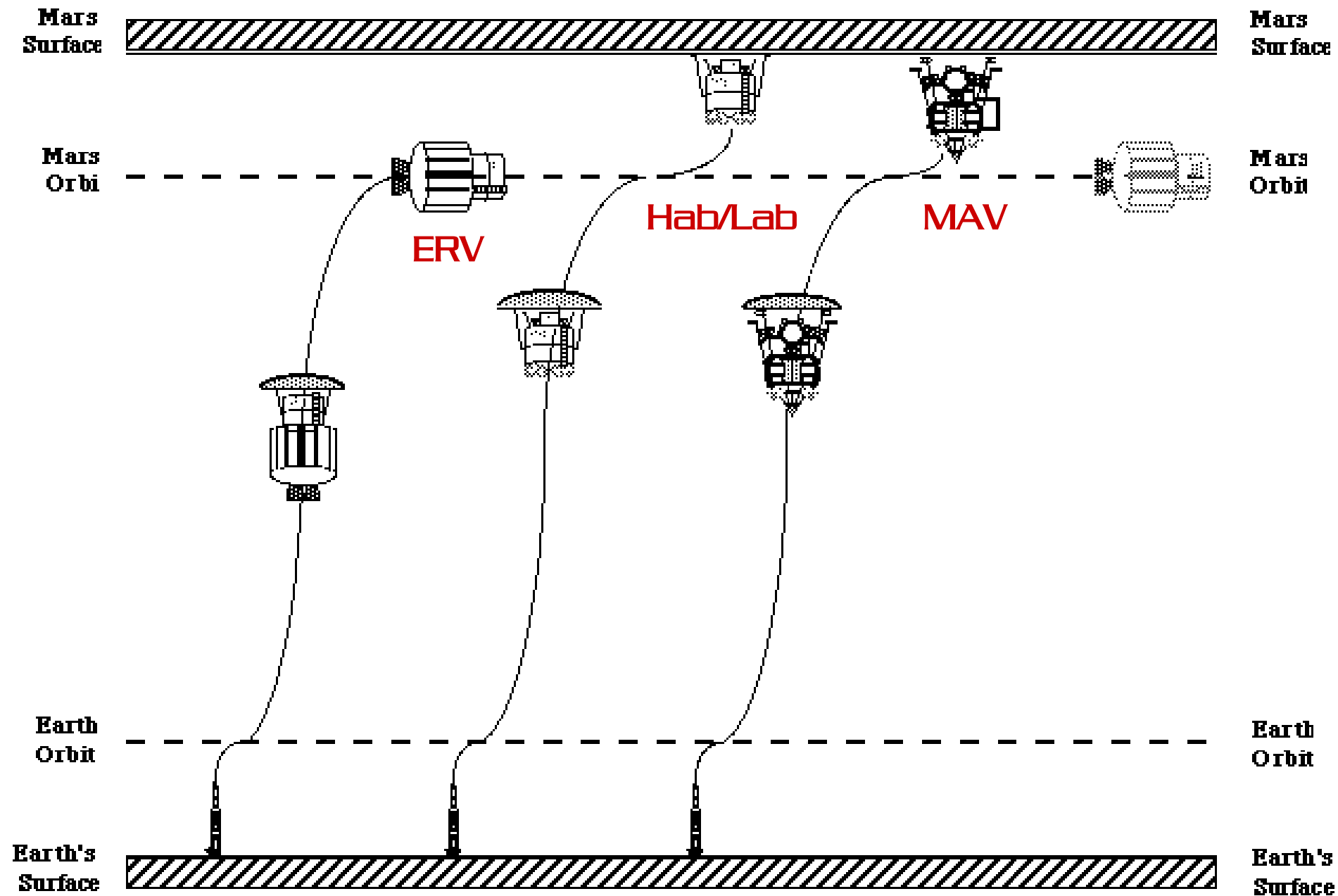




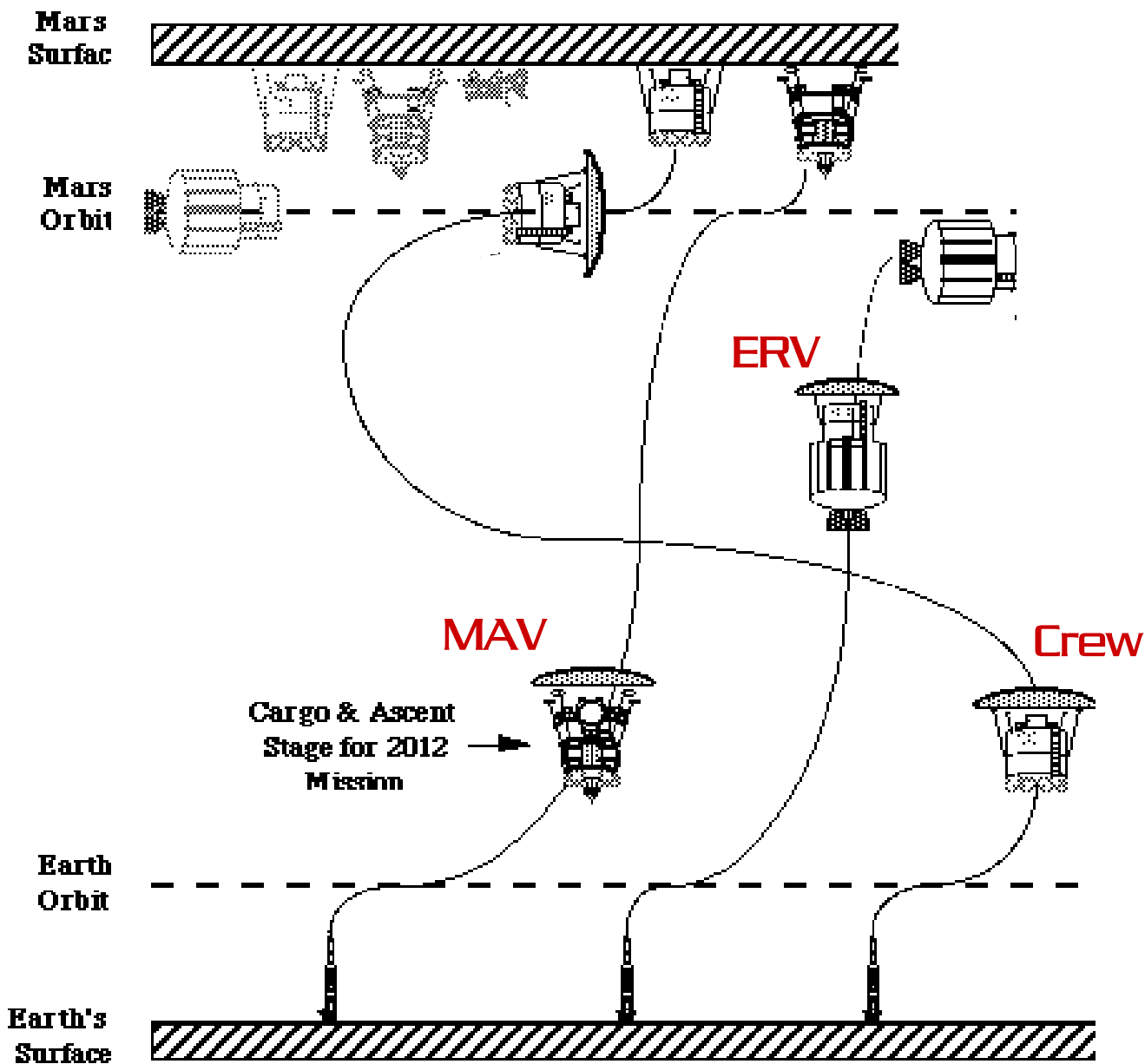
DRM 3.0



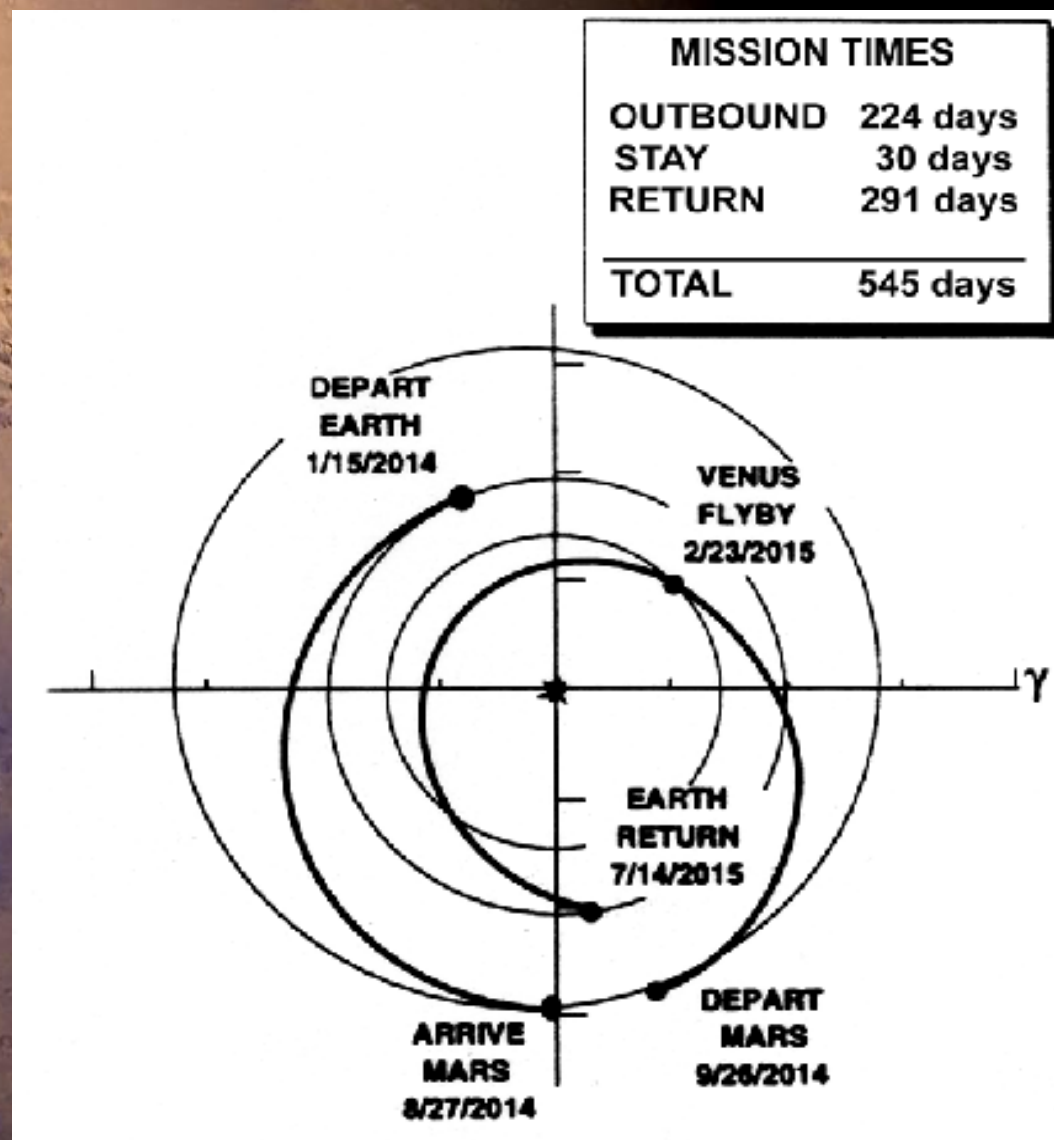
1 st Launch window



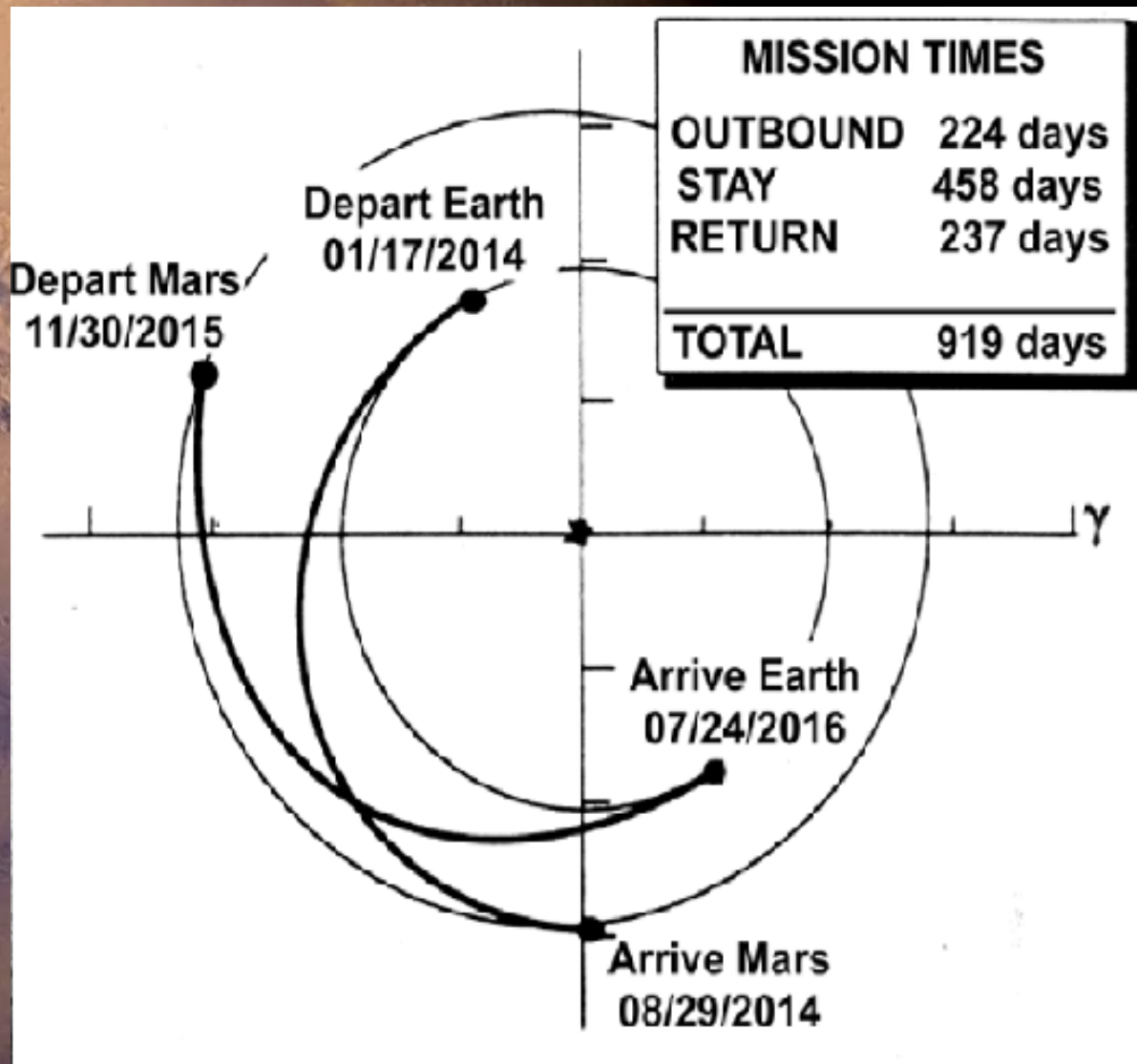
2nd Launch window



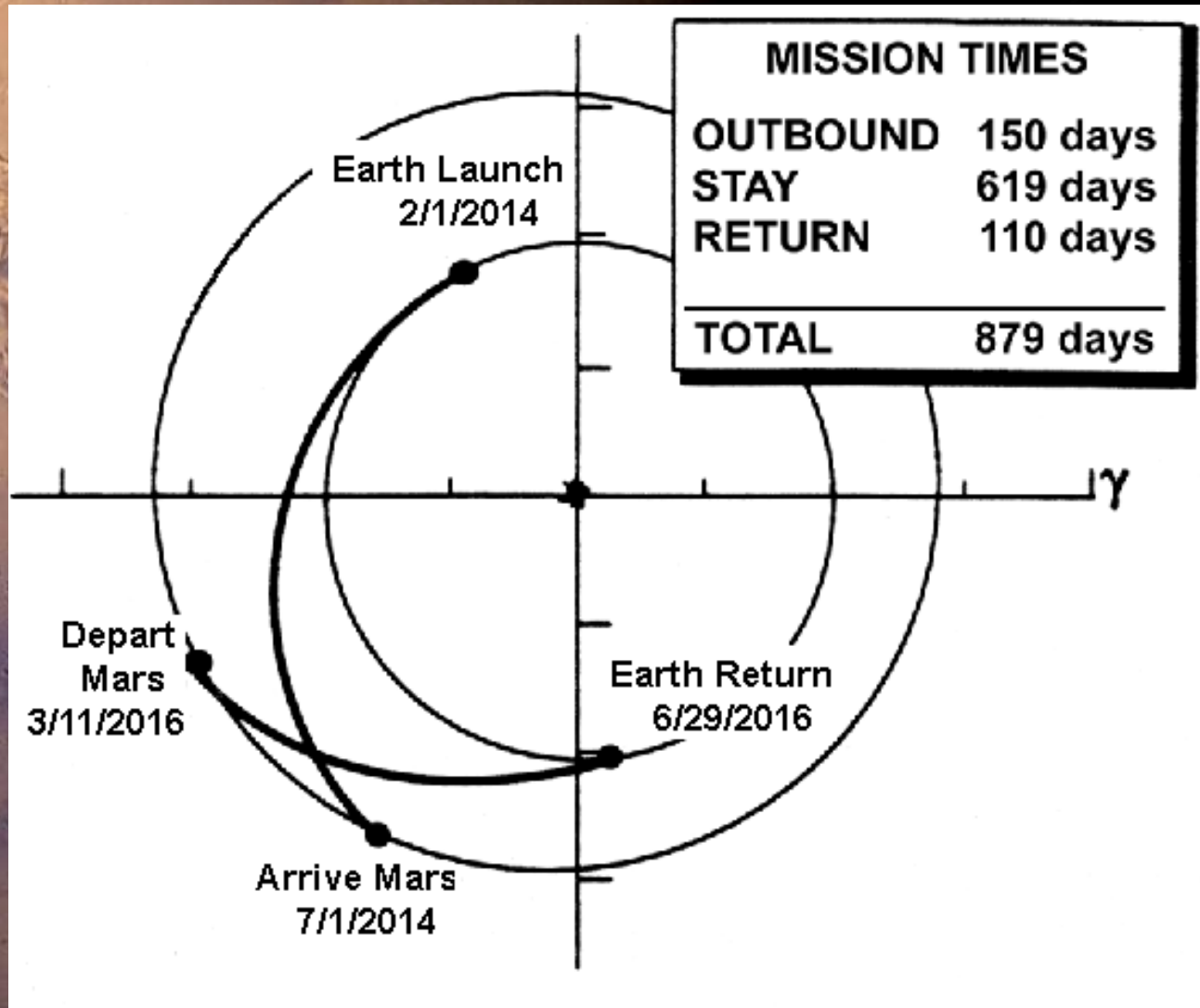
Short stay



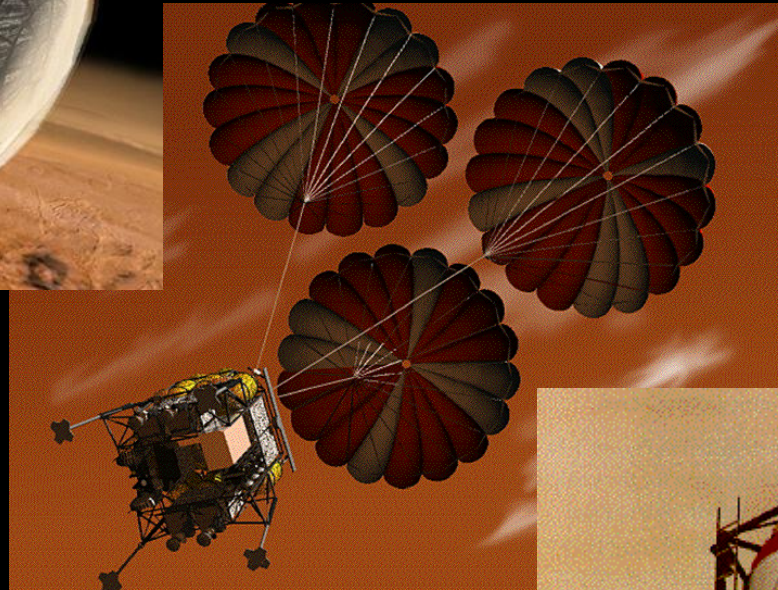
Long stay 1



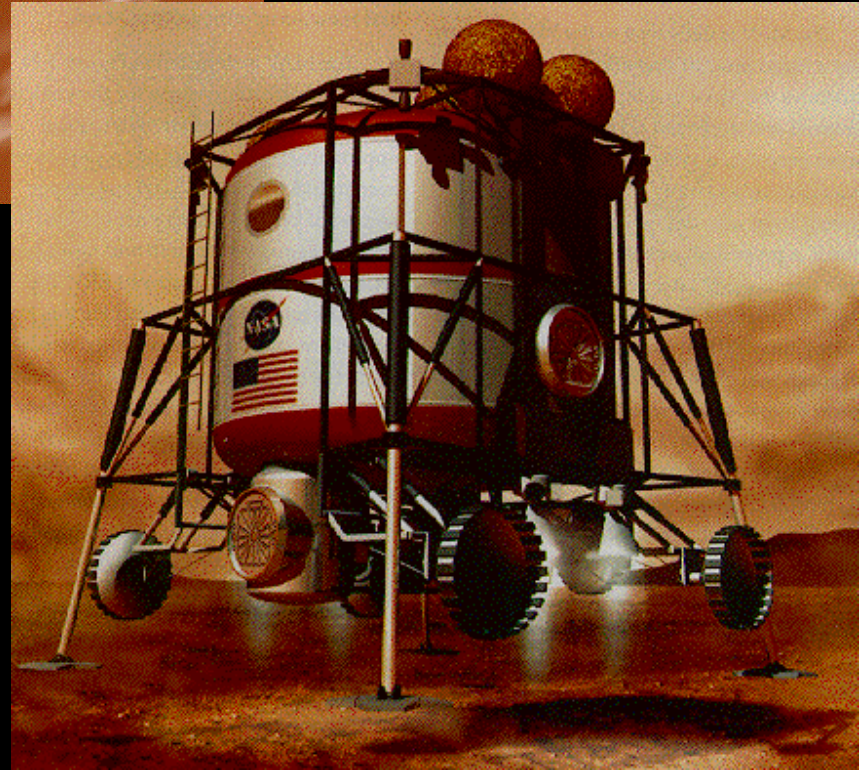
Long Stay 2



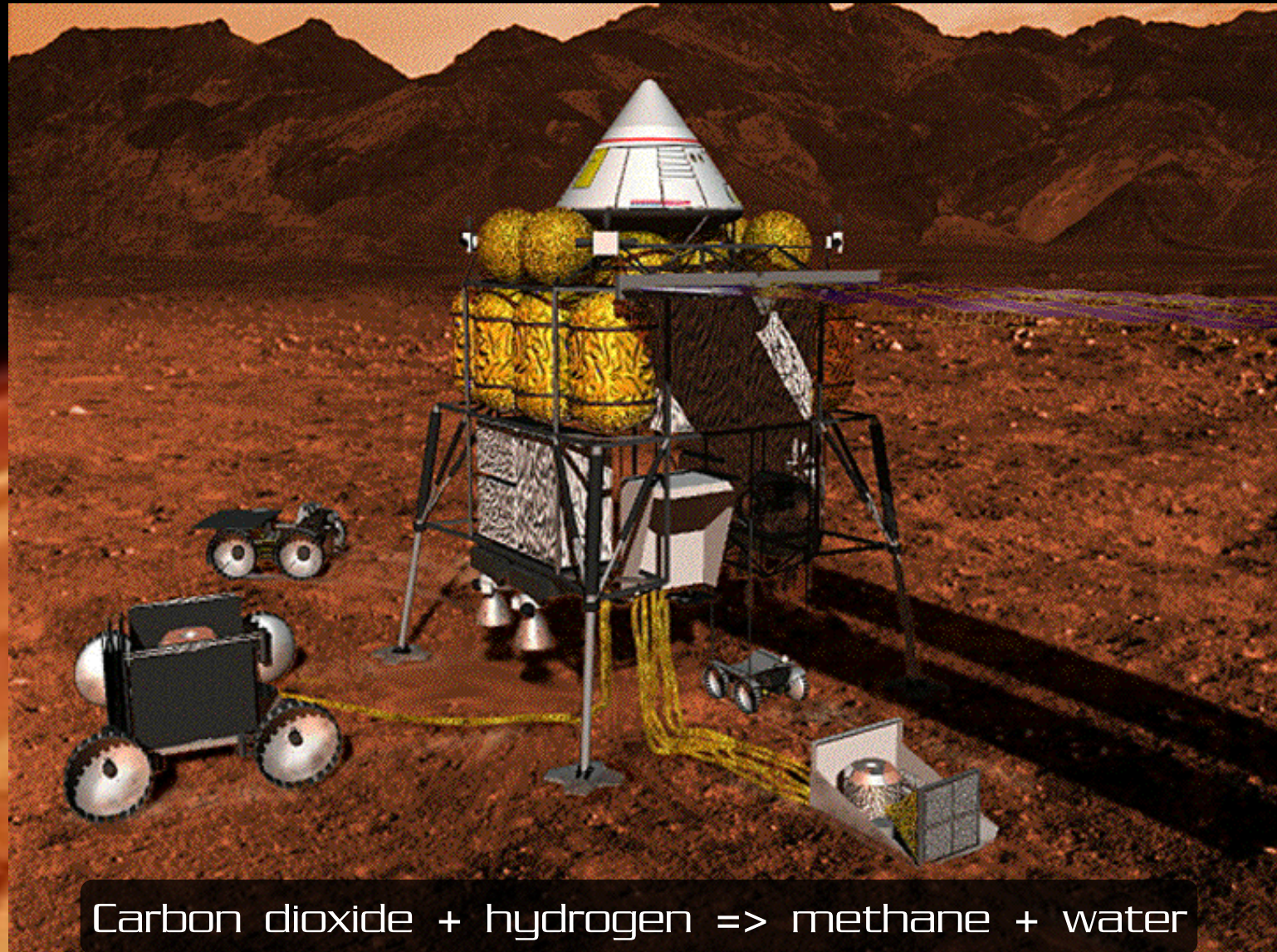
Deceleration



Landing

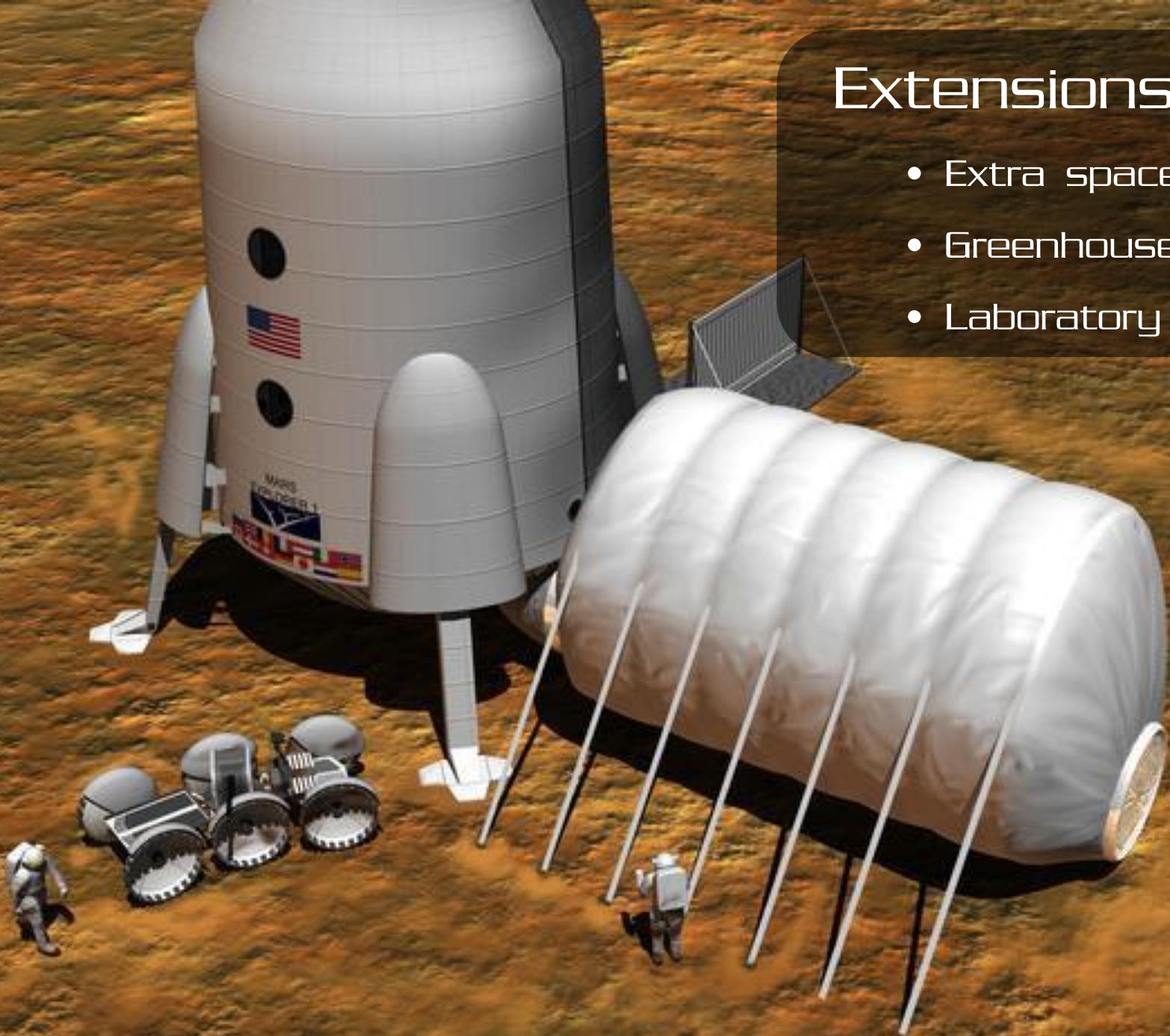


ISRU

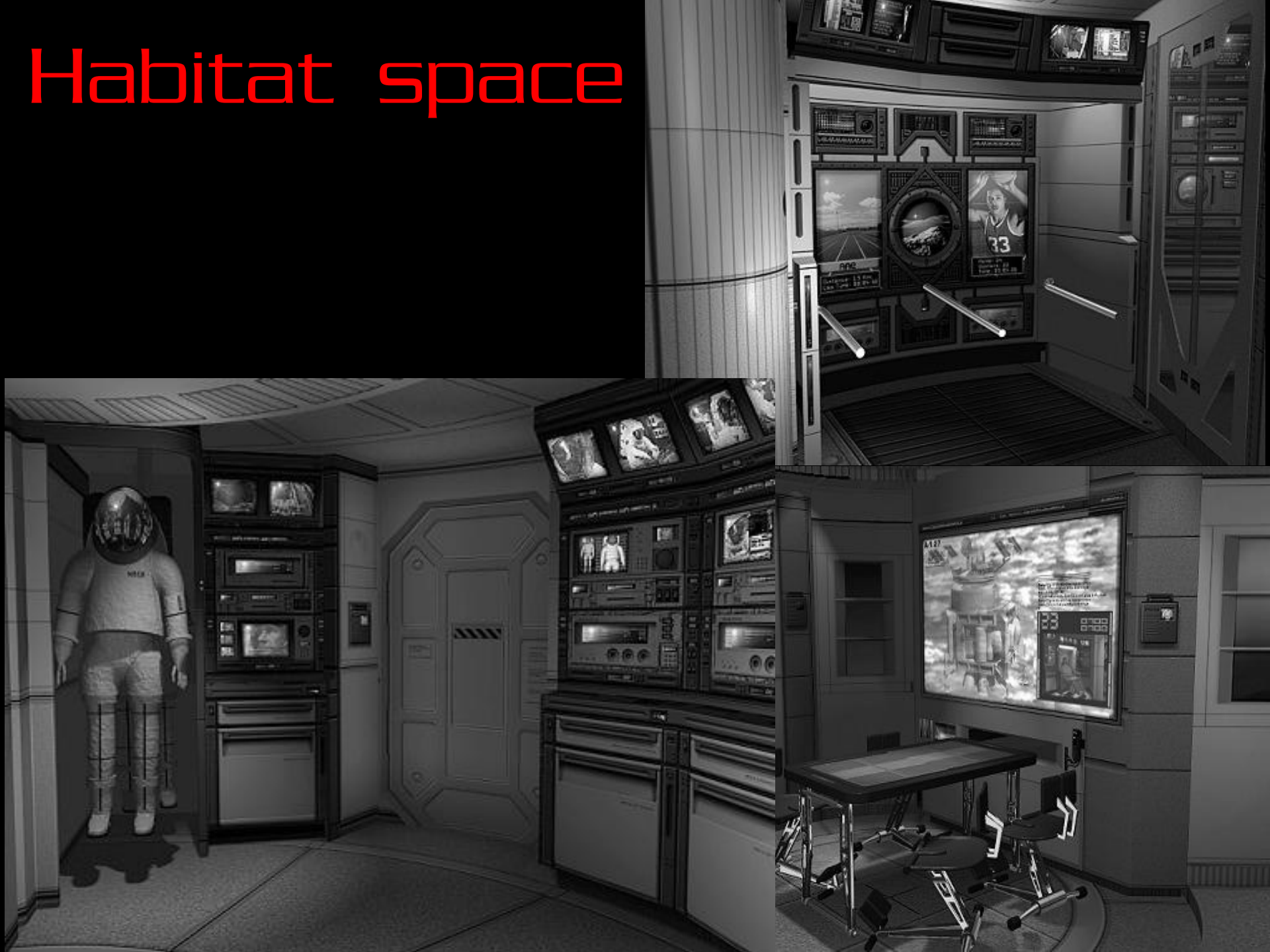


Extensions

- Extra space
- Greenhouse
- Laboratory

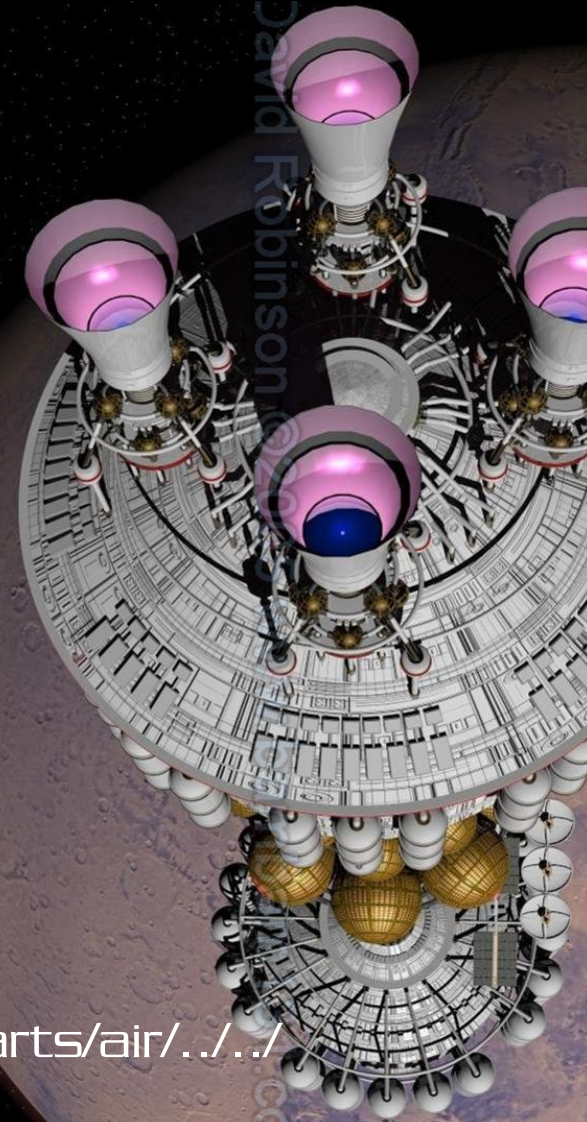


Habitat space



Habitat space

- Lab
- Medical facilities
- Air docks
- Hygiene / toilette / laundry facilities
- Energy source
- Life support system
- Kitchen/diner
- Communication
- R&R
- Sleeping space
- Maintenance
- Storage food/water/waste/equipment/spare parts/air/.../...





Mars on Earth

Flashline
Mars
Arctic
Research
Station

Mars
Desert
Research
Station

MDRS

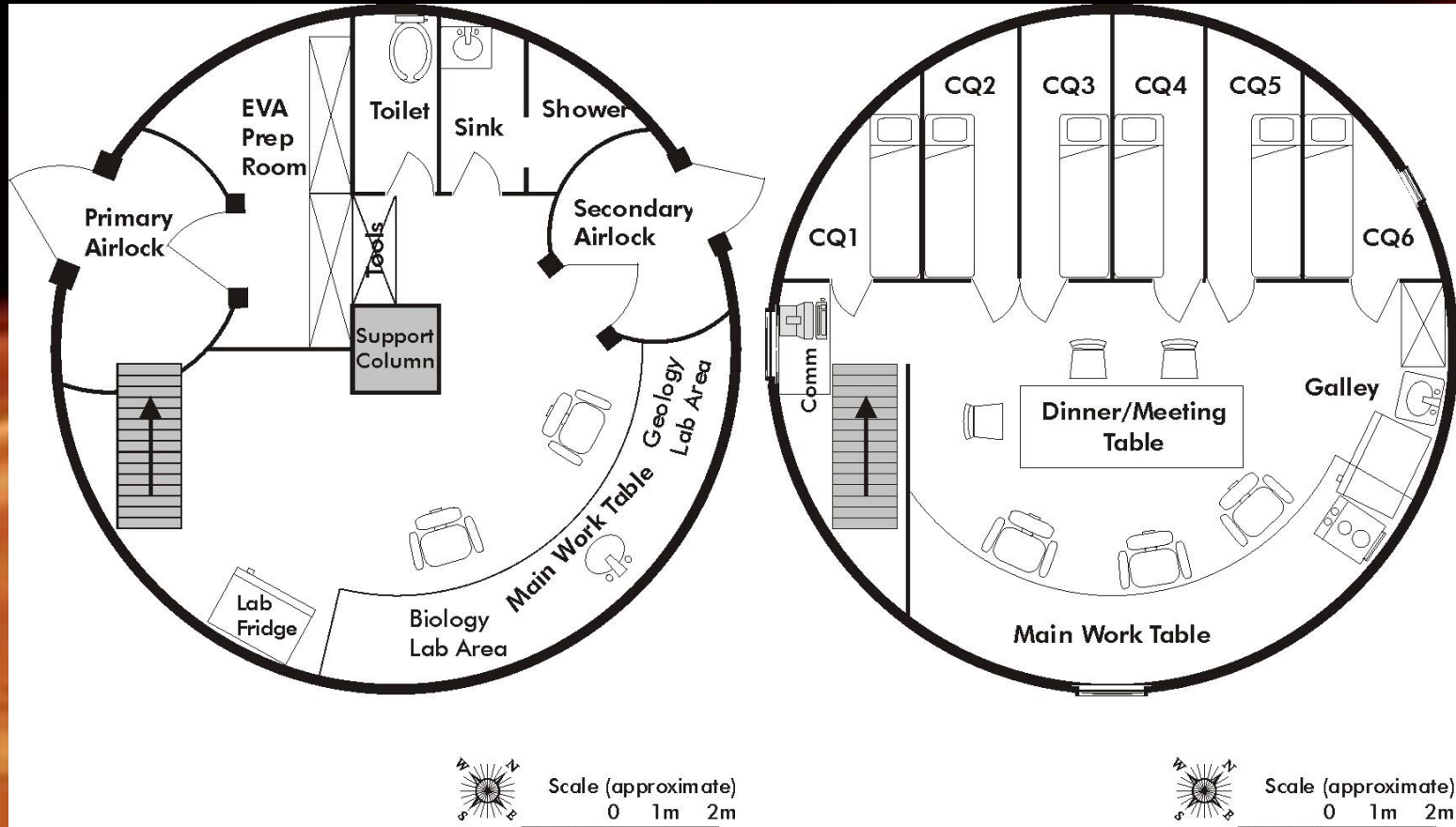




FMARS



Layout



Special tools / equipment?



Crew

- Expertise?
- Number of crewmembers?
- Couples?
- Nationalities?
- Mix of males and females?

Field work



22 8:22 PM

Transportation



Navigation?



Exploring





Geology



Biology?



Recreation

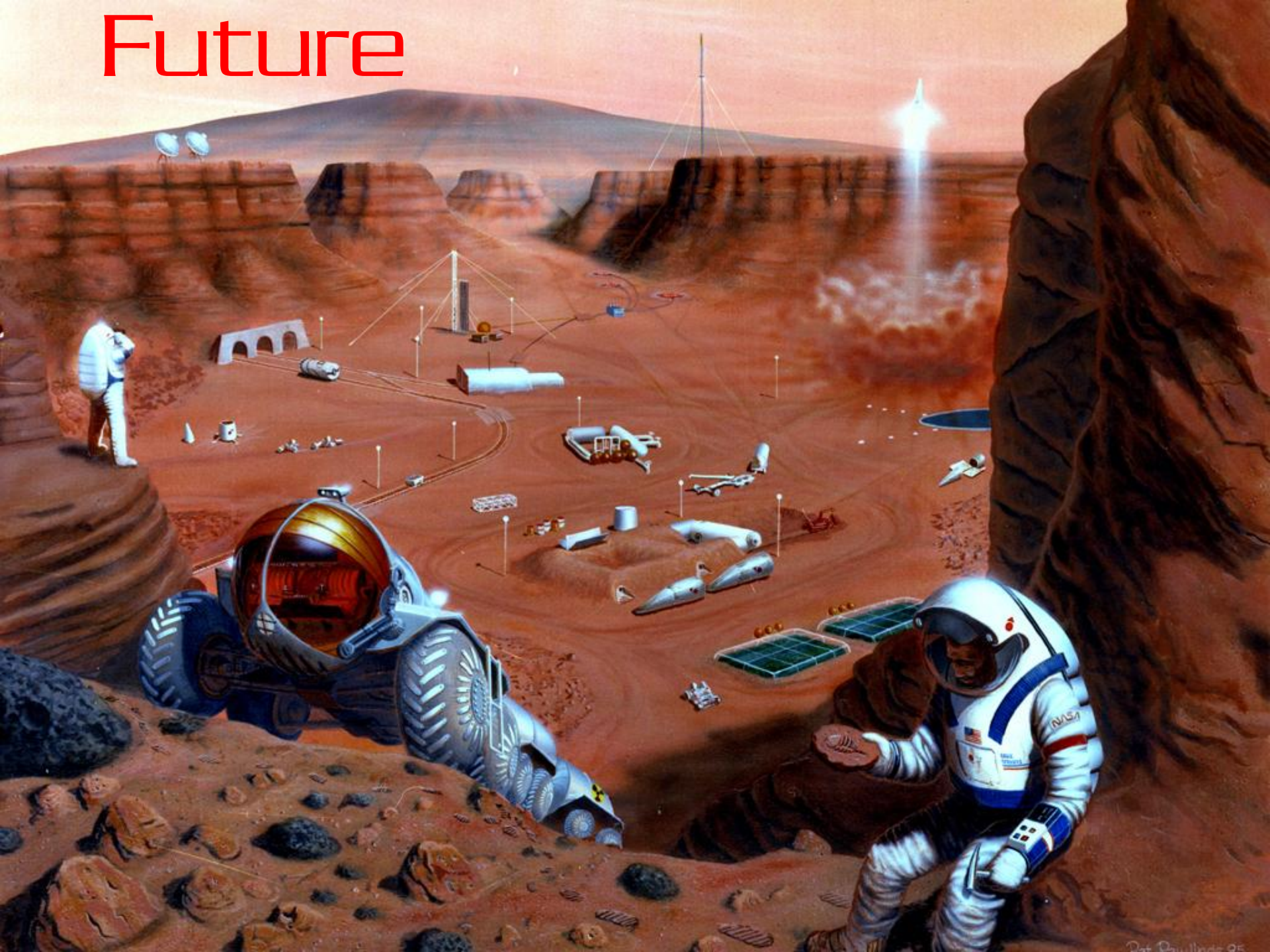
Which personal item would you bring?





Can a rover pass this rocky Canyon?

Future



Terraforming



On to Mars!



www.ellaspace.com