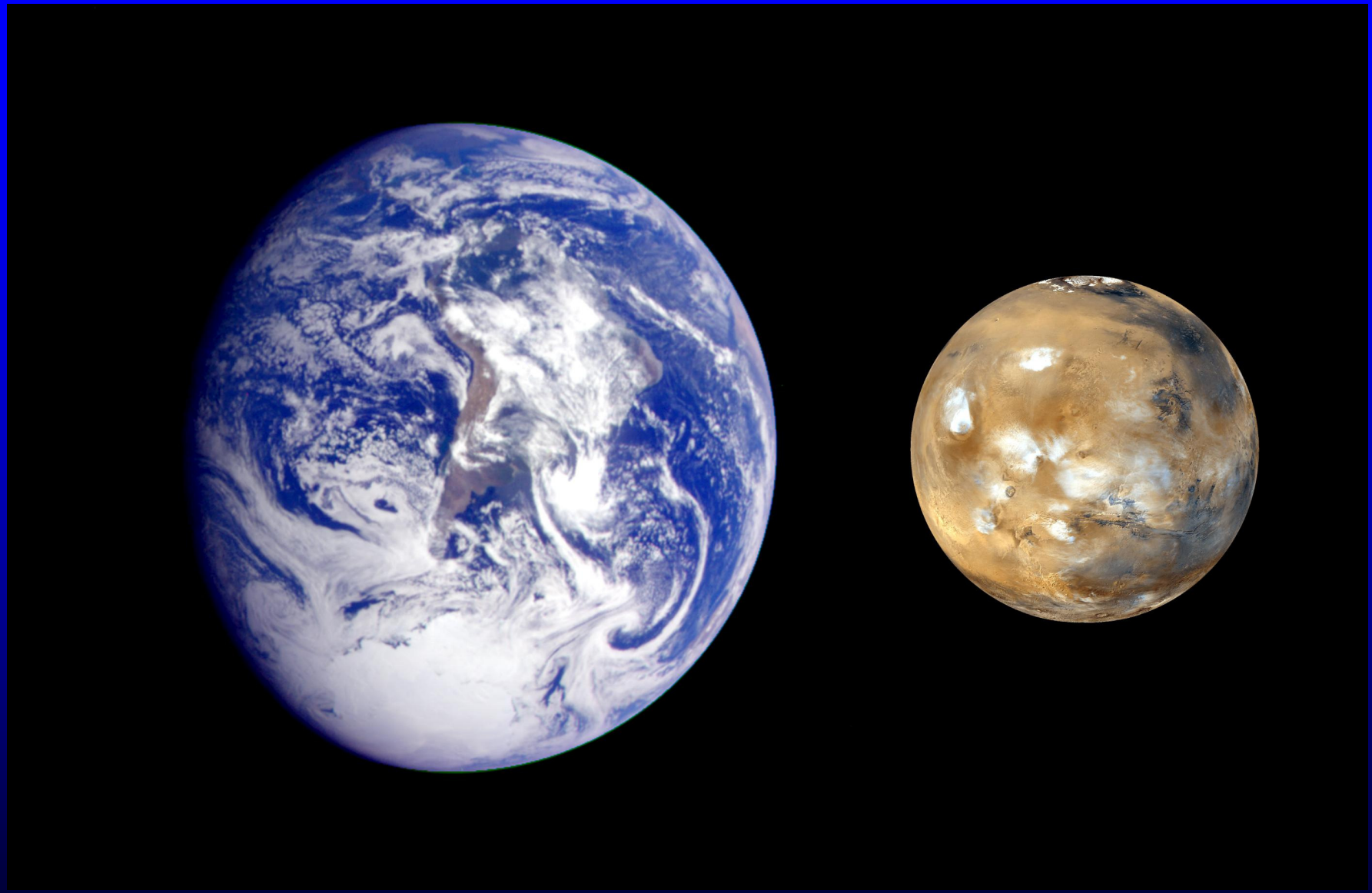
MANCHESTER 1824
Jodrell Bank Observatory

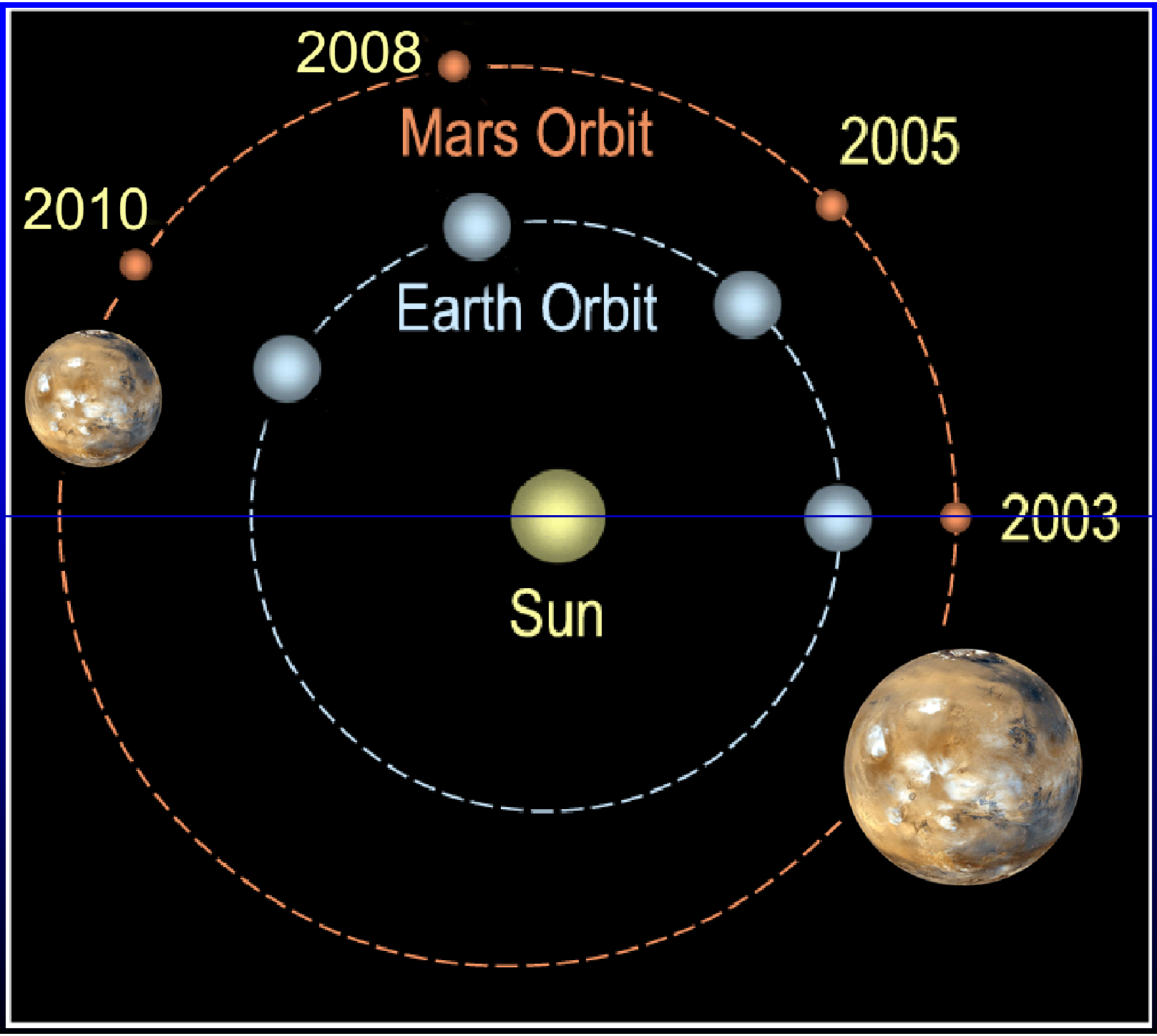
GRESHAM COLLEGE

Life on Mars?

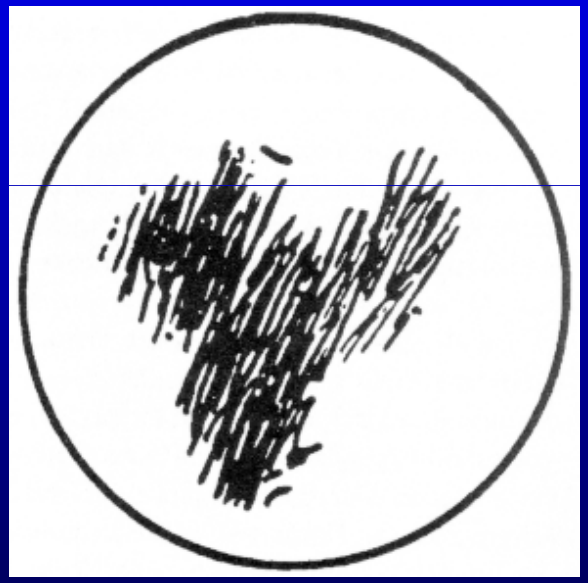
Ian Morison

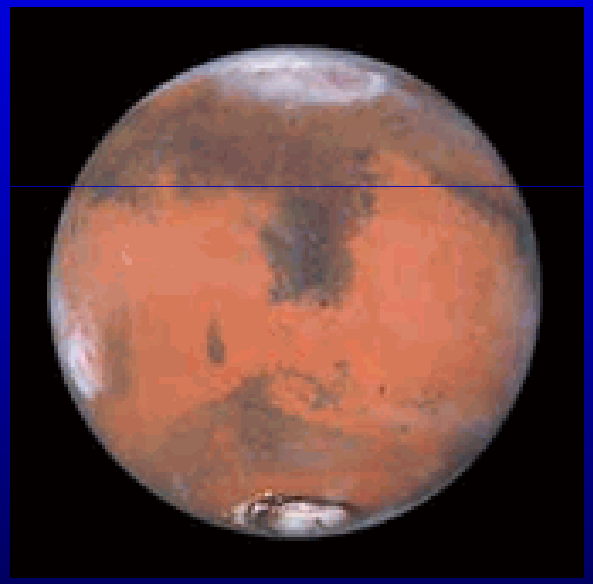
Gresham Professor of Astronomy




2008
Mars Orbit
2005
2010
Earth Orbit
2003
Sun

Christiaan Huygens observed Mars Oct 13th 1659





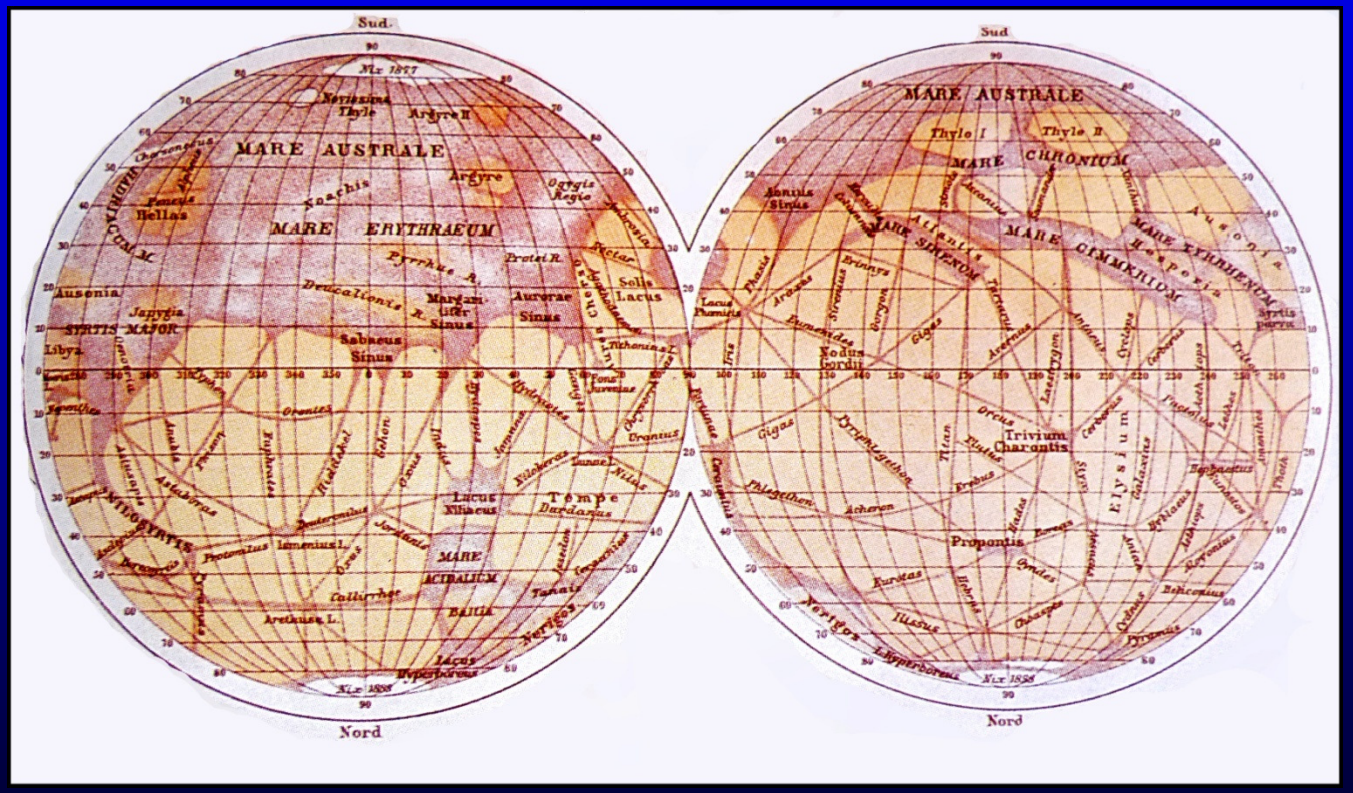
Syrtis Major

He estimated Mars' size and its ~24 hr day


Giovanni Virginio Schiaparelli

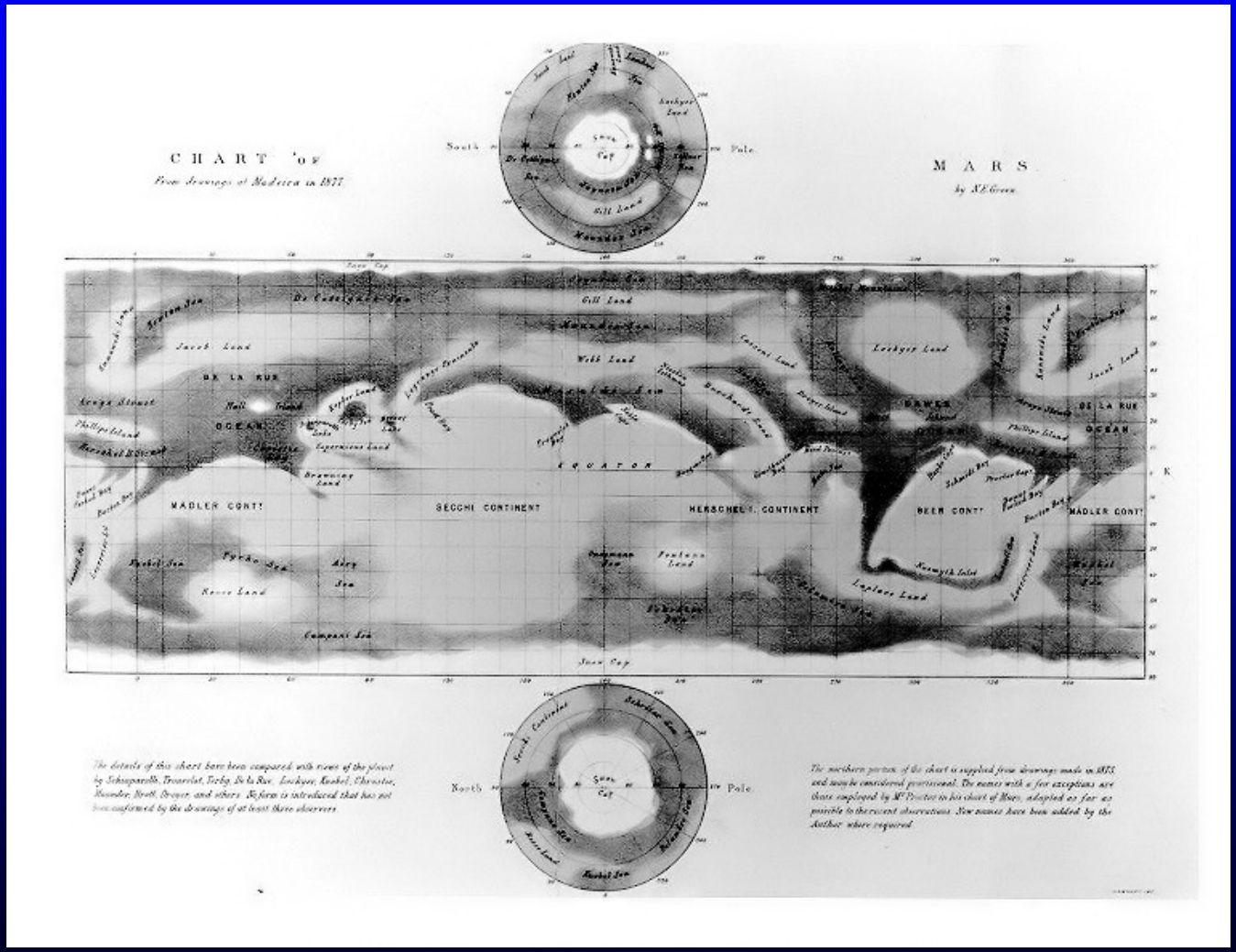
Schiaparelli's map of 1877

- Called some features "canali".
- Could mean "channels" or "canals".

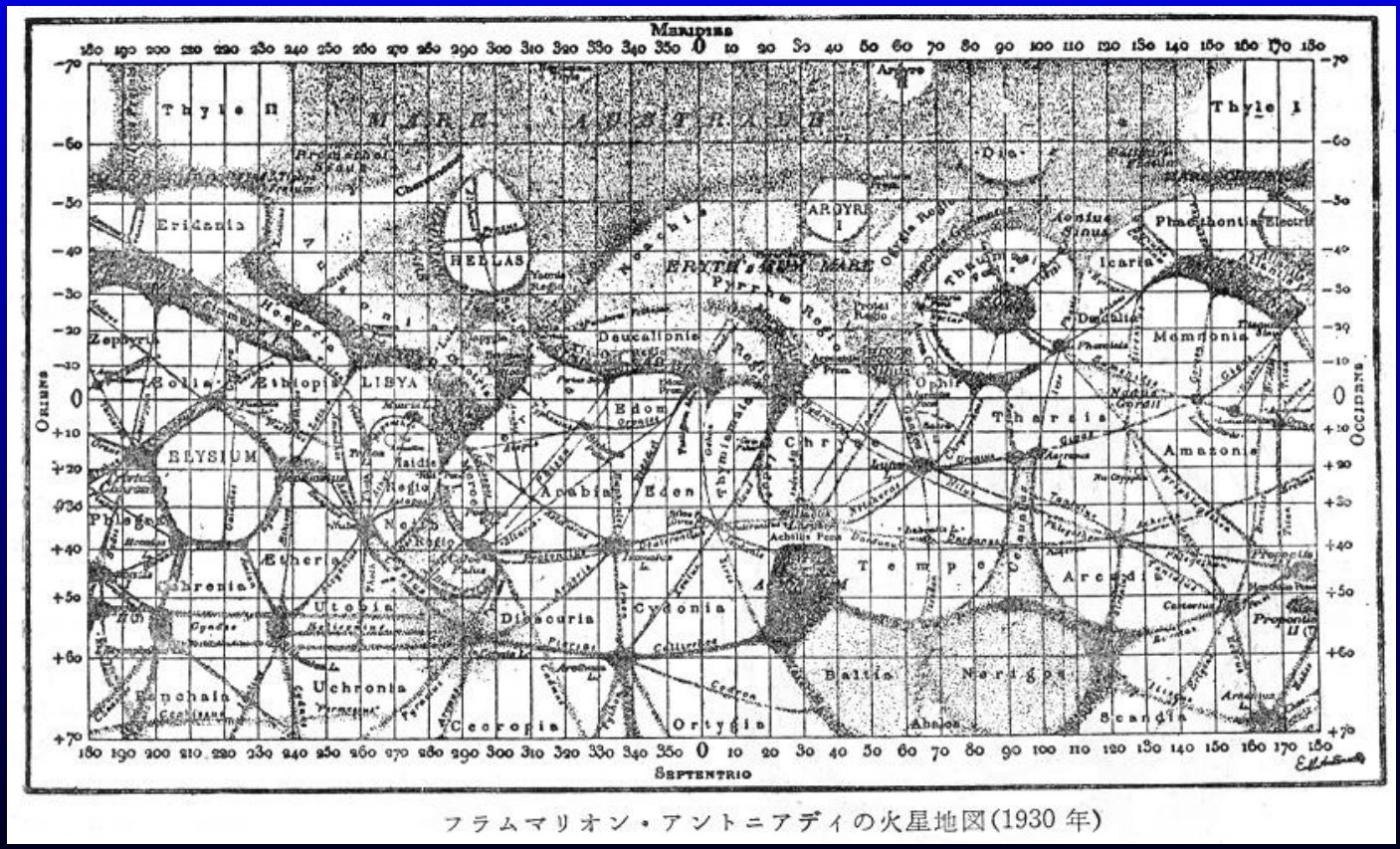


Nathaniel Green's Mars Map of 1877

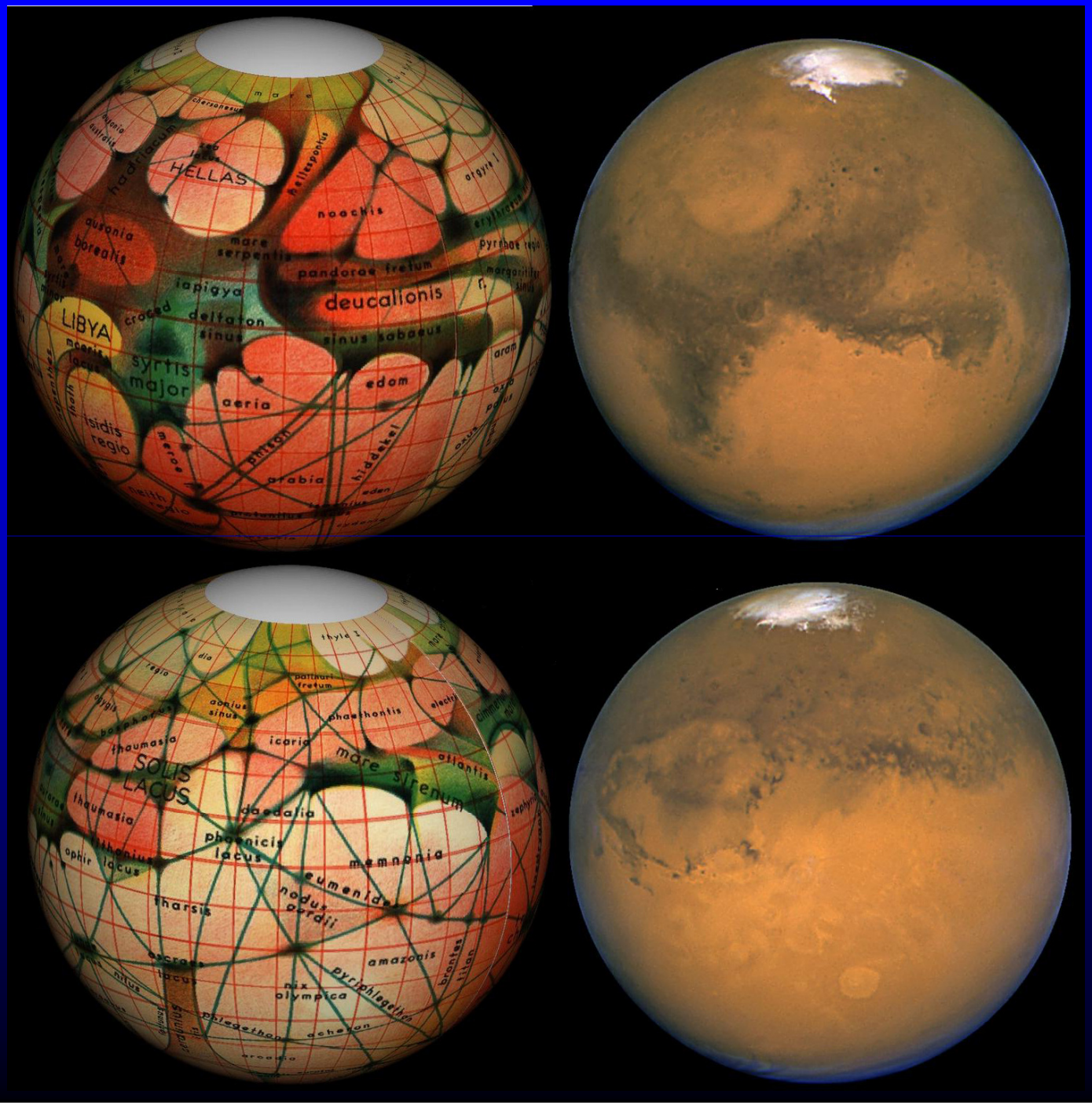
- He suggested that the "canals" were an optical illusion



Eugine Antoniadi



フラムマリオン・アントニアディの火星地図(1930 年)


HELLAS
hadriacum
Astapus
noachis
ausonia
borealis
mare serpentis
pandorae fretum
iapigya
deucalionis
LIBYA
deltaton
sinus
sinus sabaeus
syrtis major
aeria
edom
isidis regio
phison
arabia
hiddekel
thyle I
pathuri fretum
aonius sinus
phaethontis
thaumasia
icaria
mare sirenum
atlantis
SOLIS LACUS
daedalia
phoenicis lacus
memnonia
ophir lacus
eumenides
nodus gordii
tharsis
amazonis
nix olympica
pyriphlegethon
phlegethon
acheron

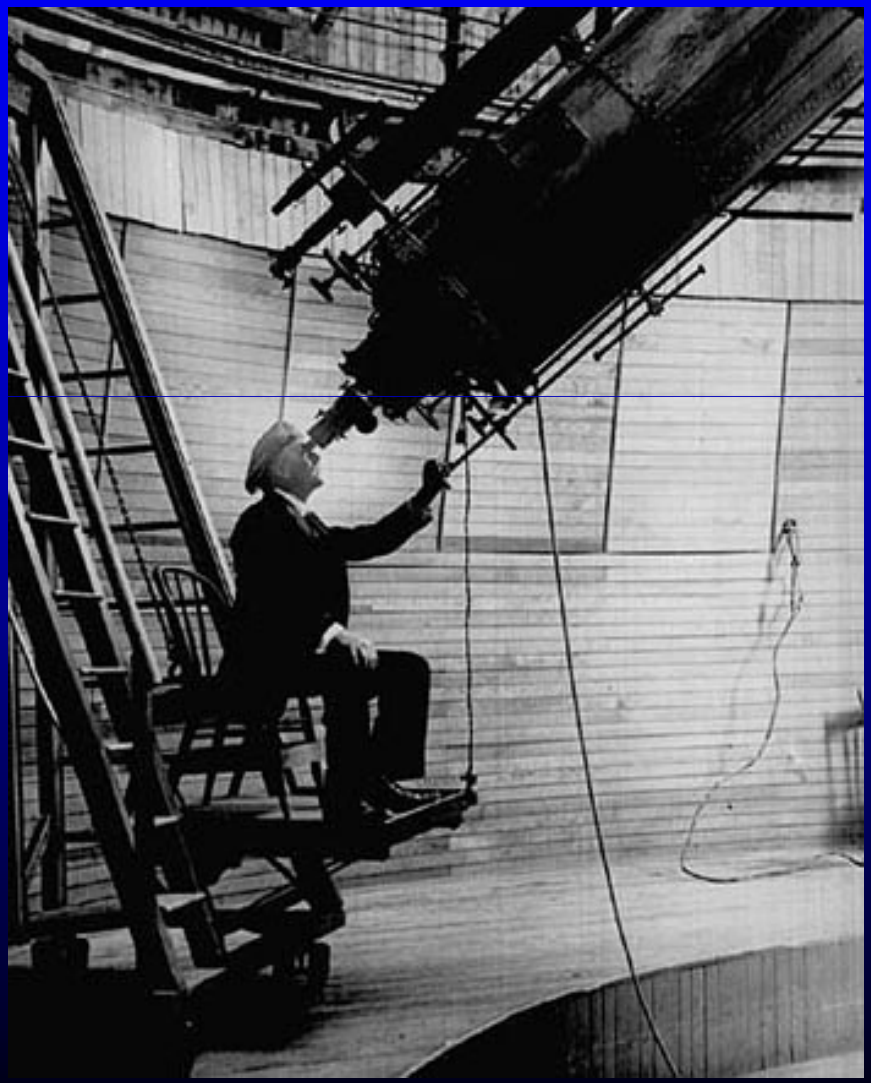
Percival Lowell

"So this is good old Boston. The home of the bean and the cod.

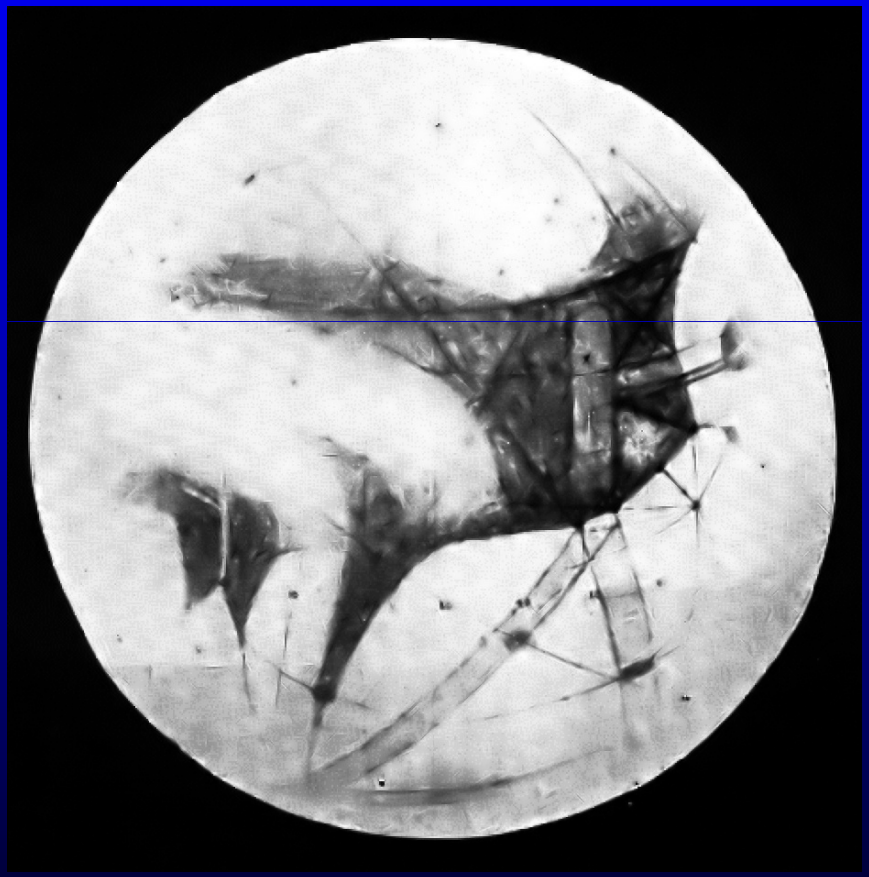
Where the Lowells talk only to the Cabots. And the Cabots talk only to God."

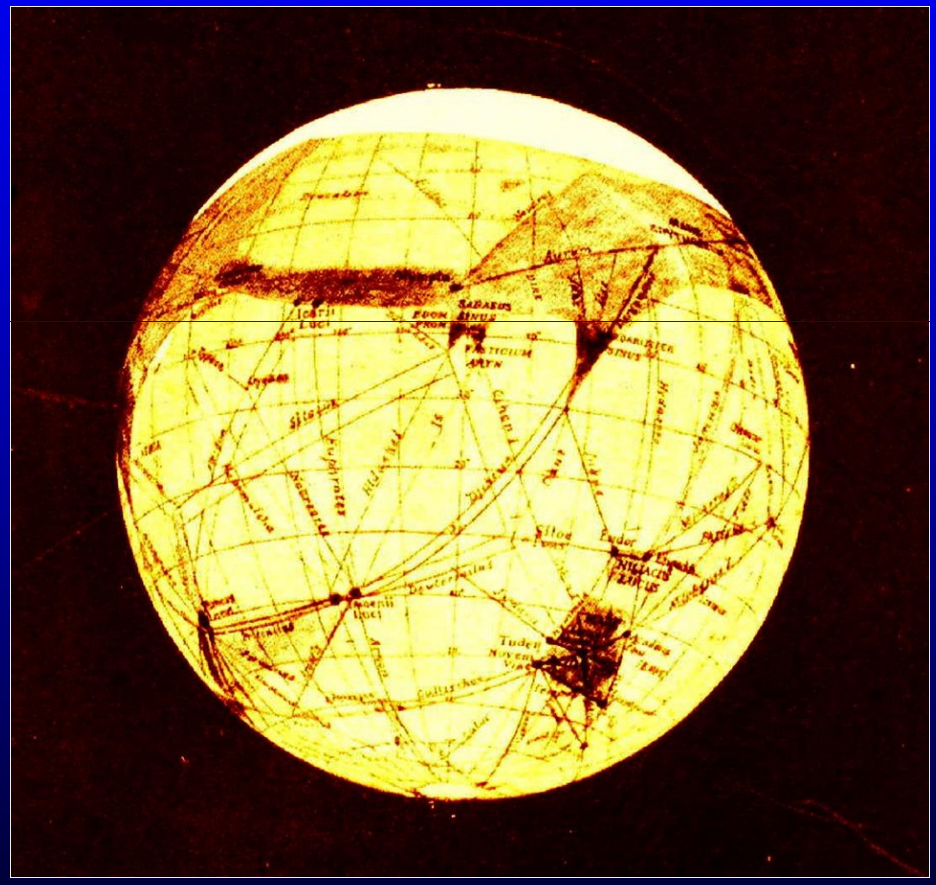
Lowell Observatory – Flagstaff Arizona

- Built the Lowell Observatory at 7000 ft for high quality “seeing”.

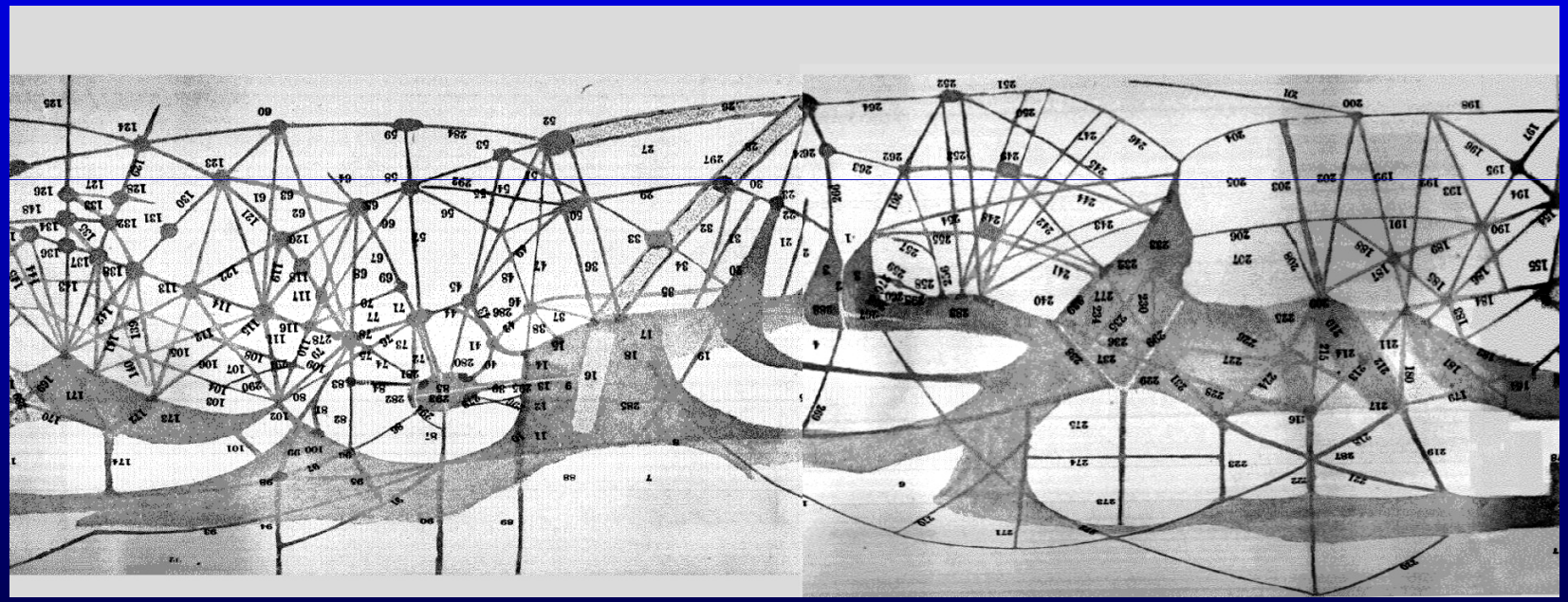


Lowell's Drawings



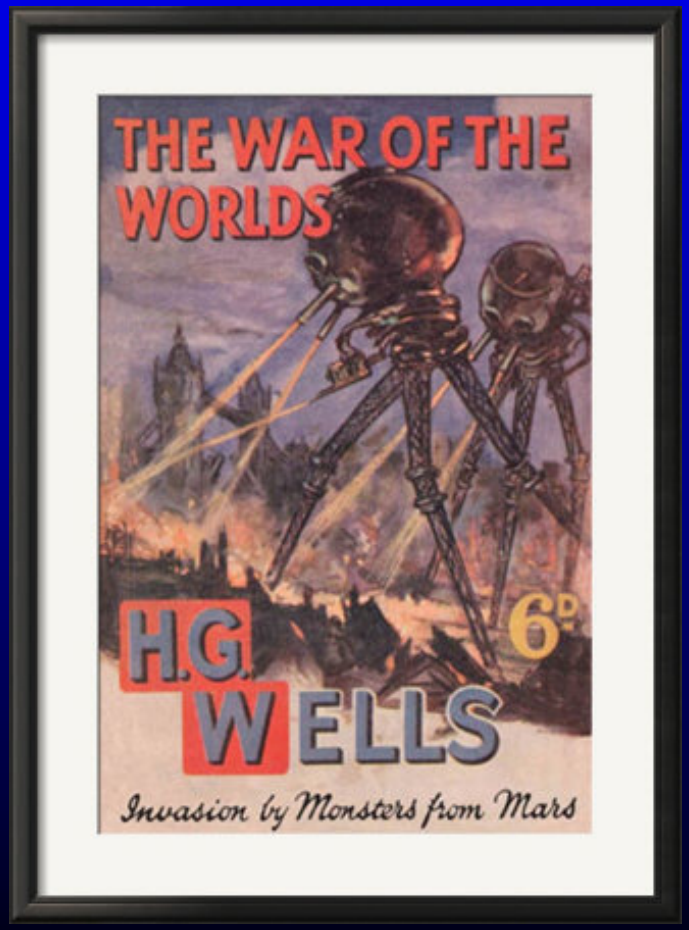


Lowell's Map of Mars



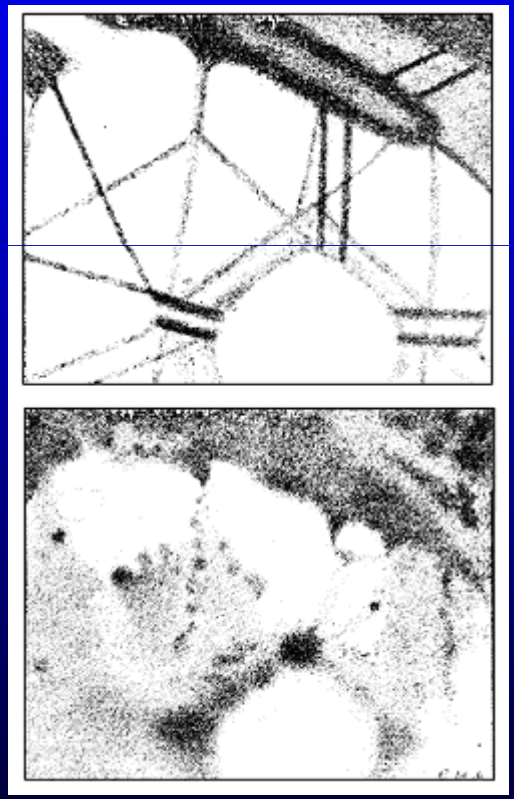
1938 – War of the Worlds

Mercury Theatre on the Air



Canals an illusion?

- Antoniadi first supported the idea of "canals", but his observations from 1909 to 1926 showed no sign of them.



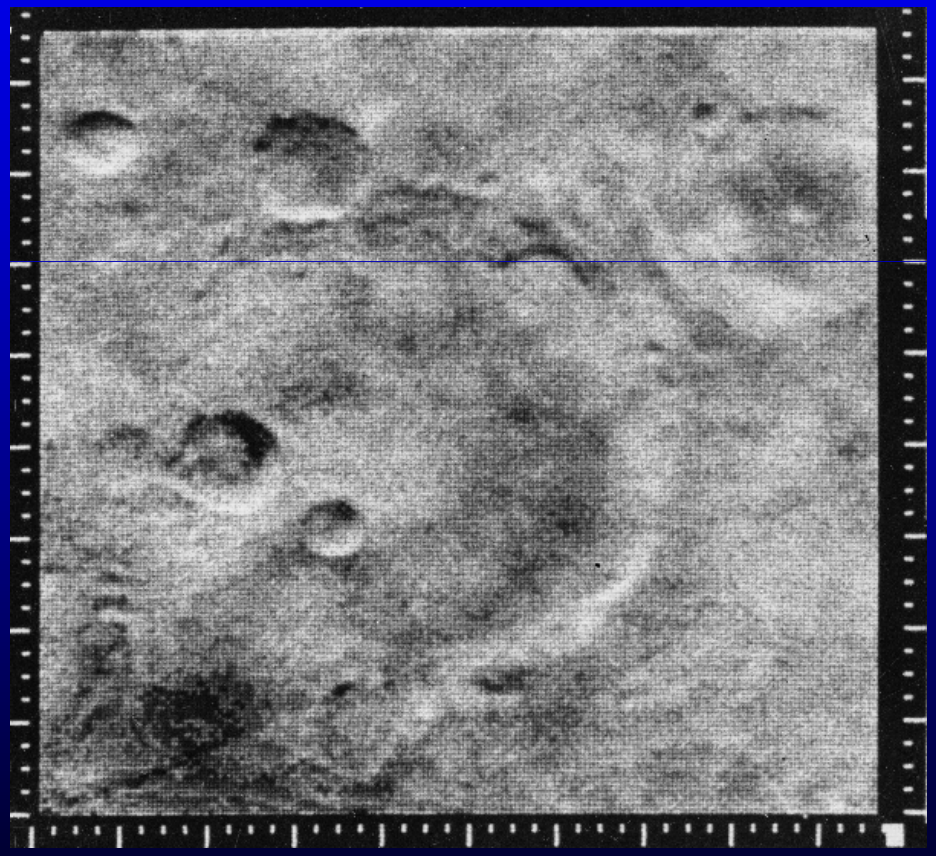
Patrick Moore's Drawing

4th February 1980

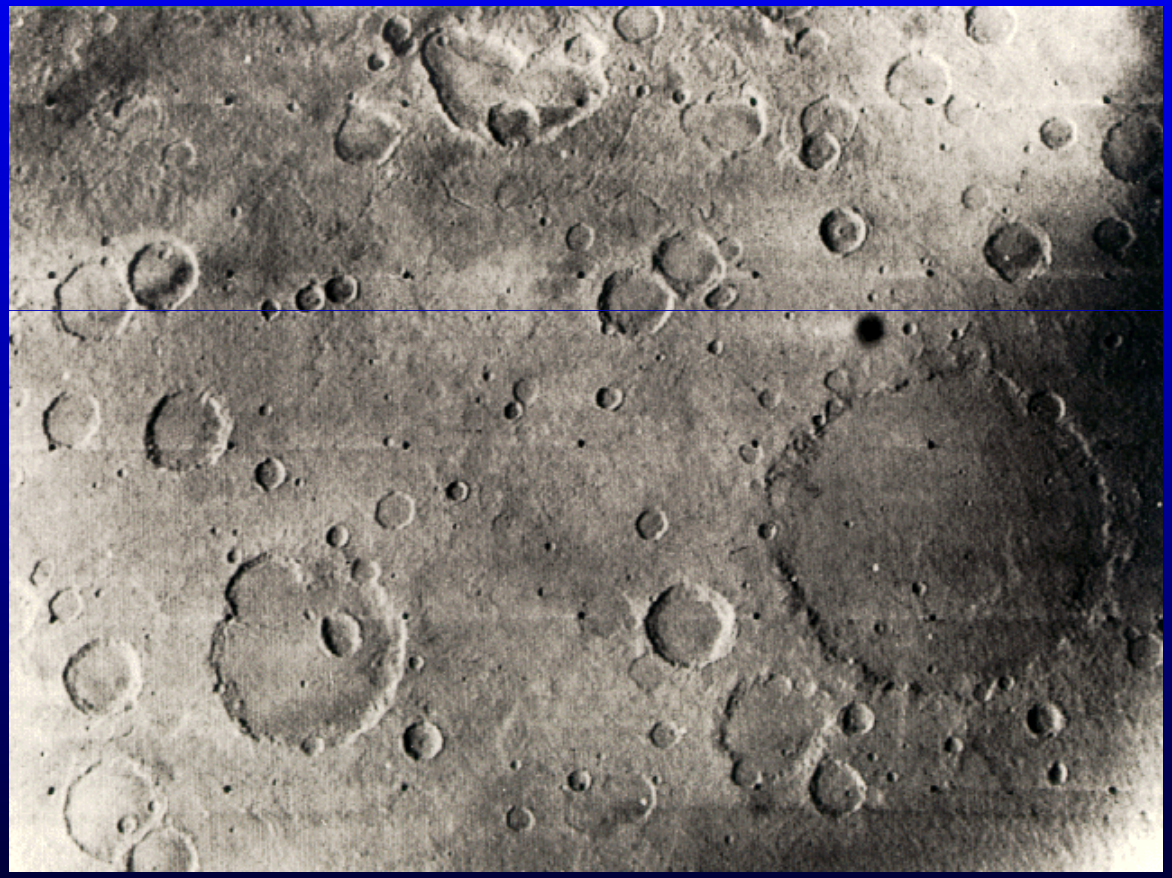
Images of Mars

Mariner and Viking Spacecraft

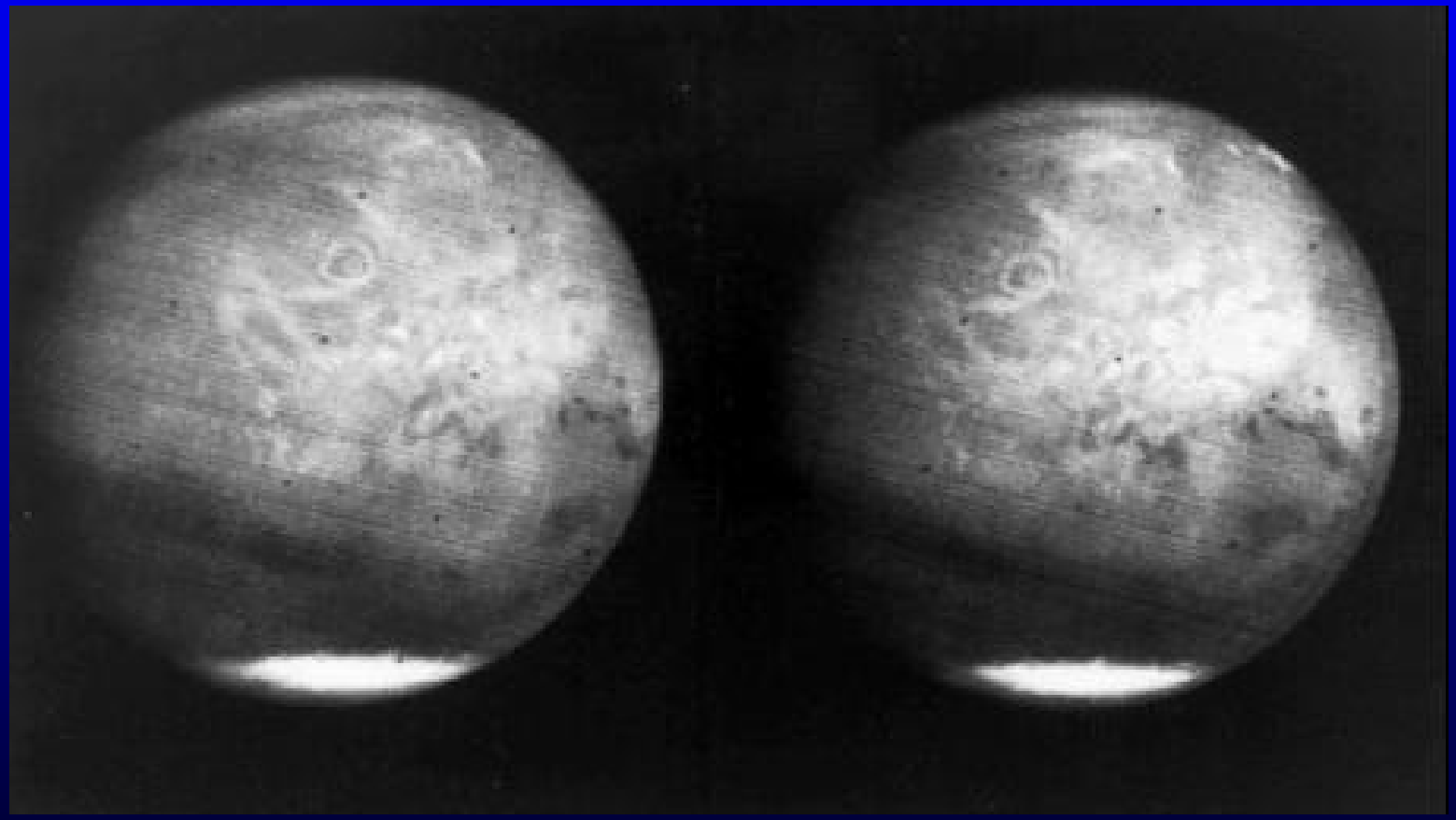
Mariner 4



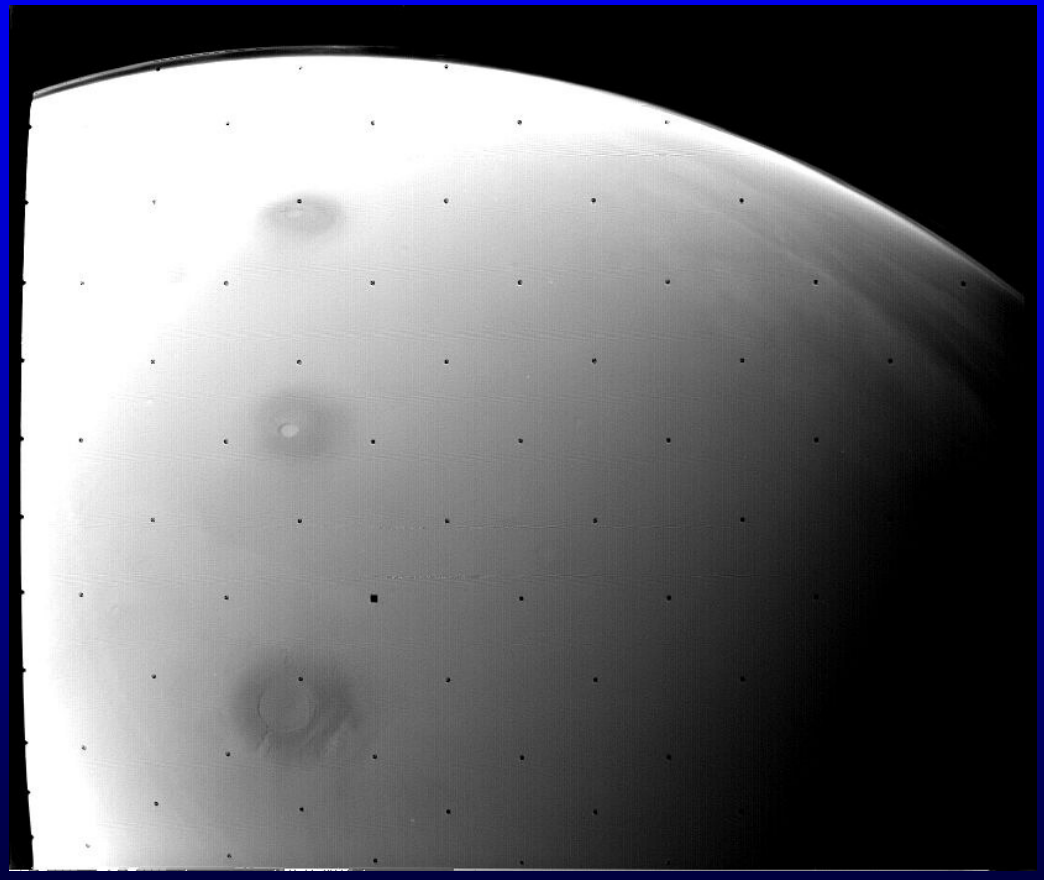
Mariner 6



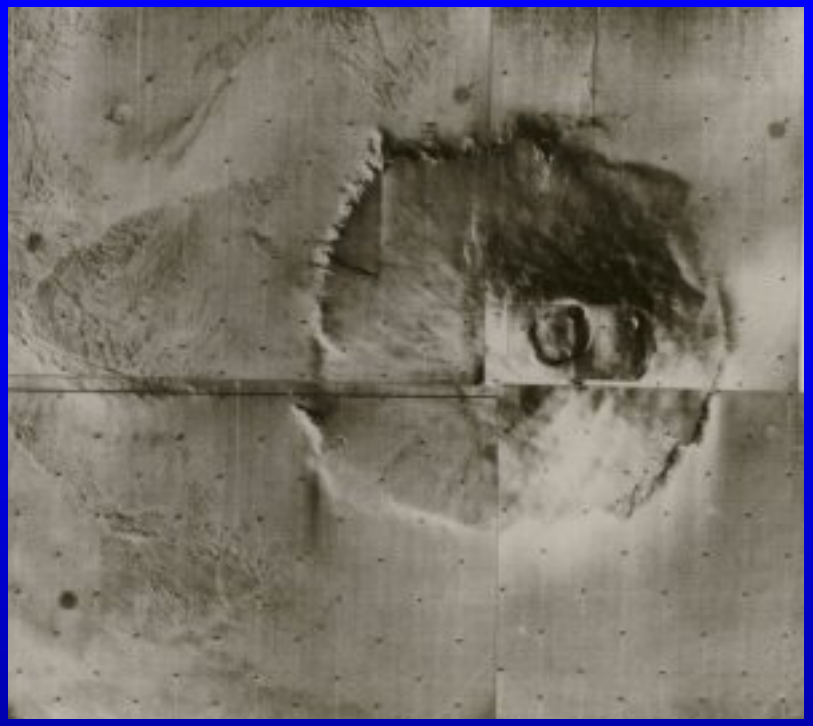
Mariners 6 and 7



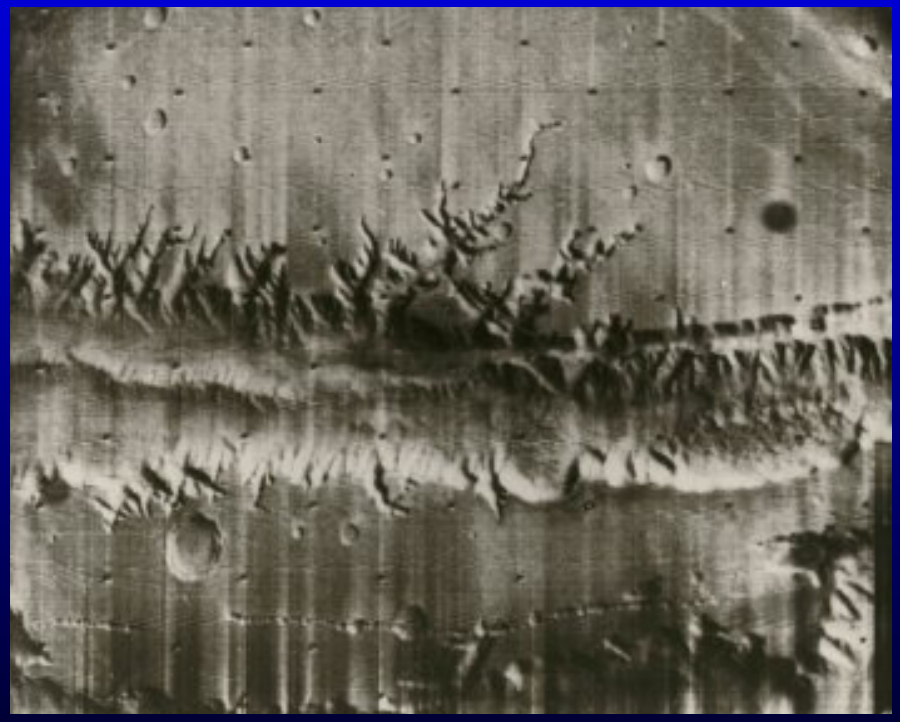
Mariners 9 and 10



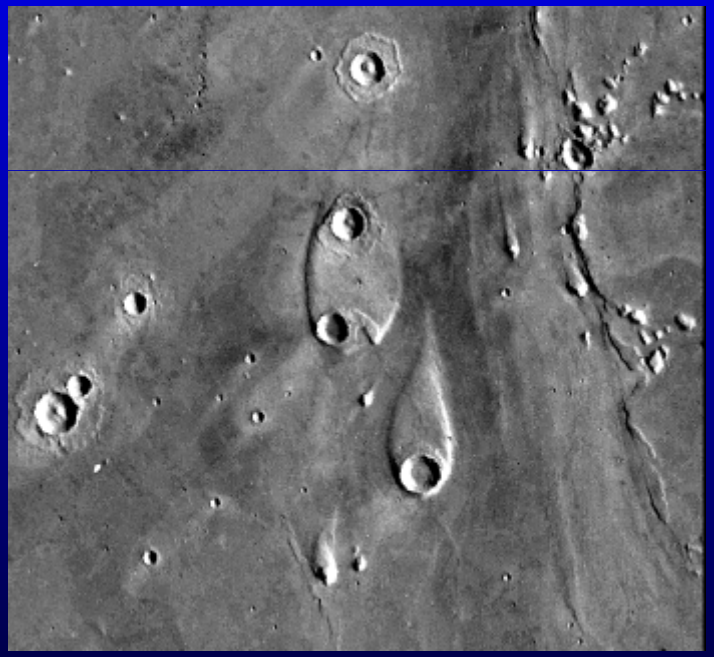
Argyre Basin

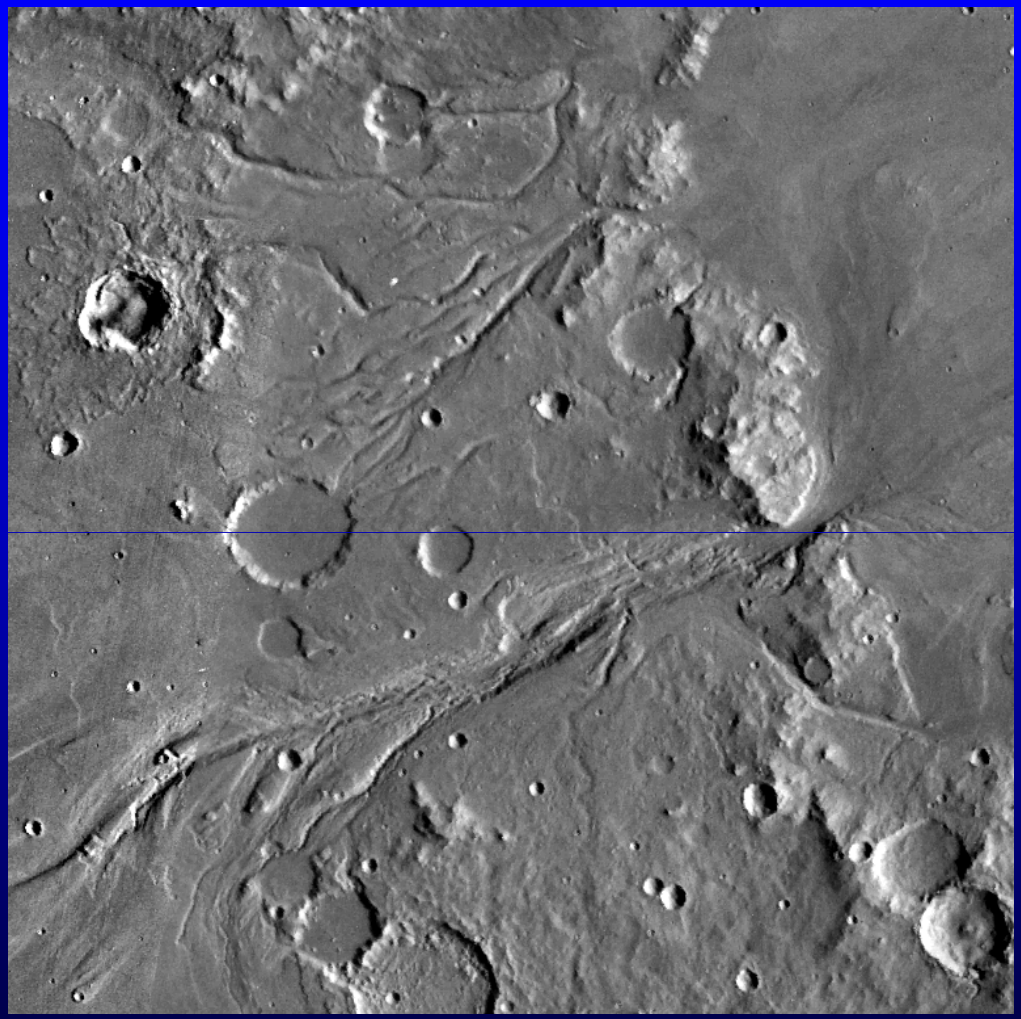


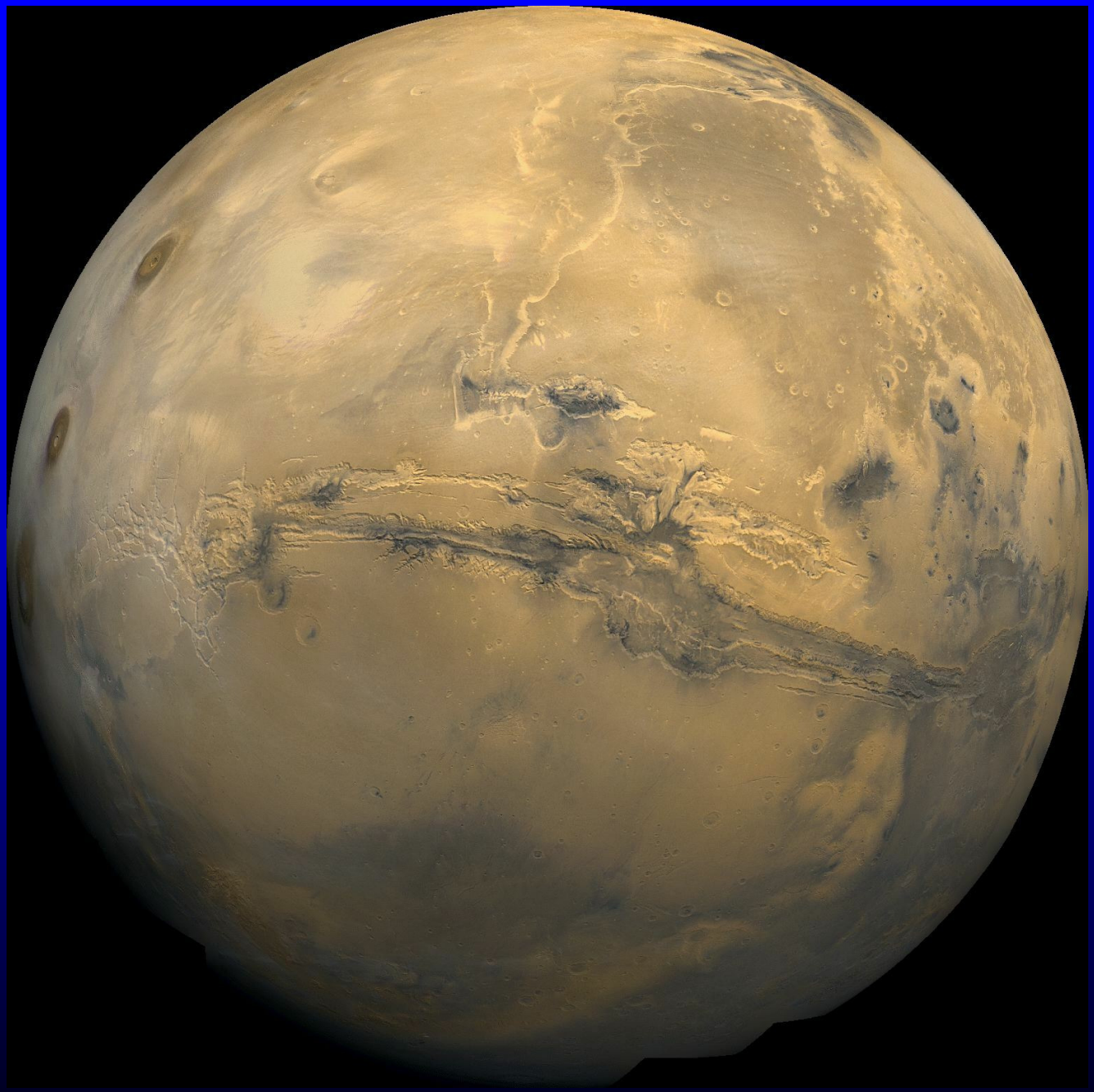
Nix Olympica (now Olympus Mons) and Vallis Marineris



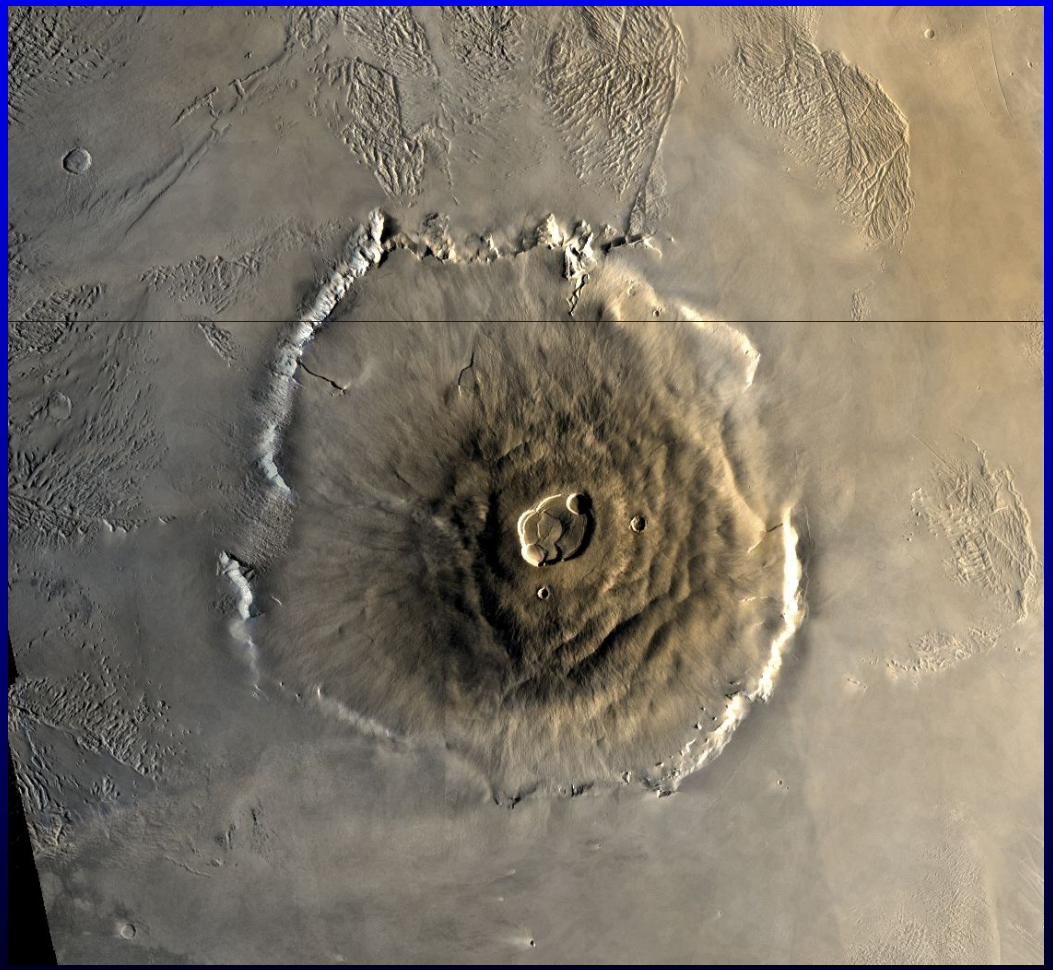
Islands and Channels







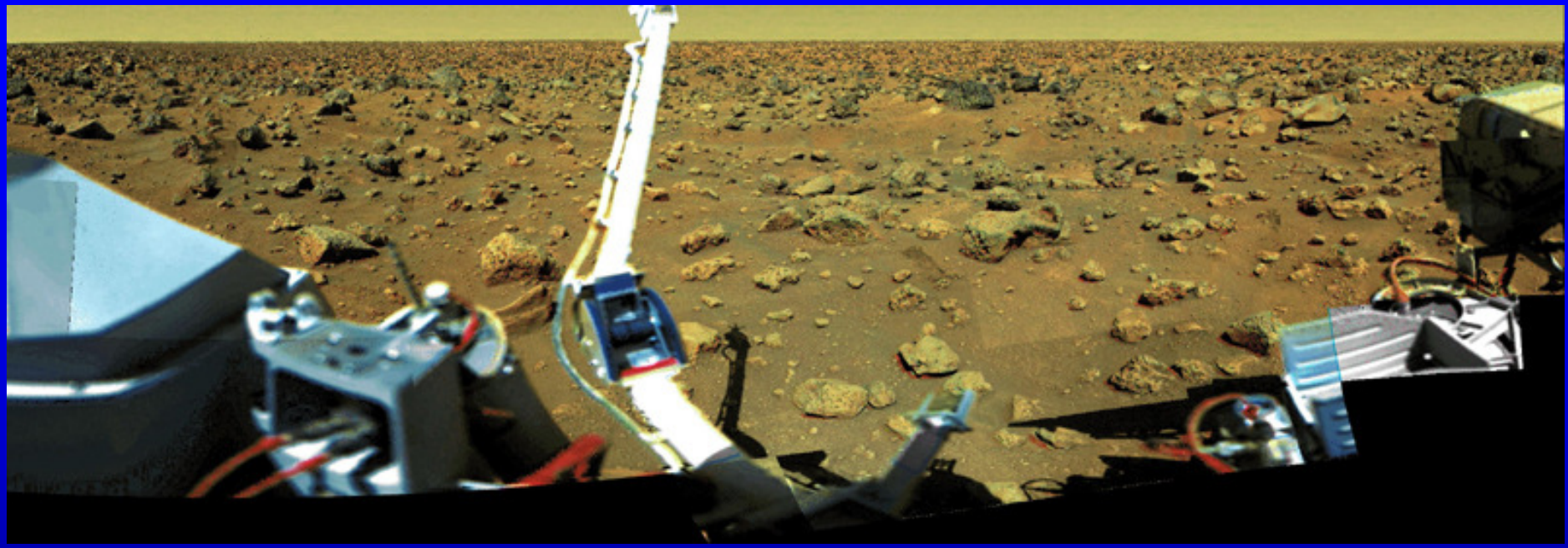
Olympus Mons



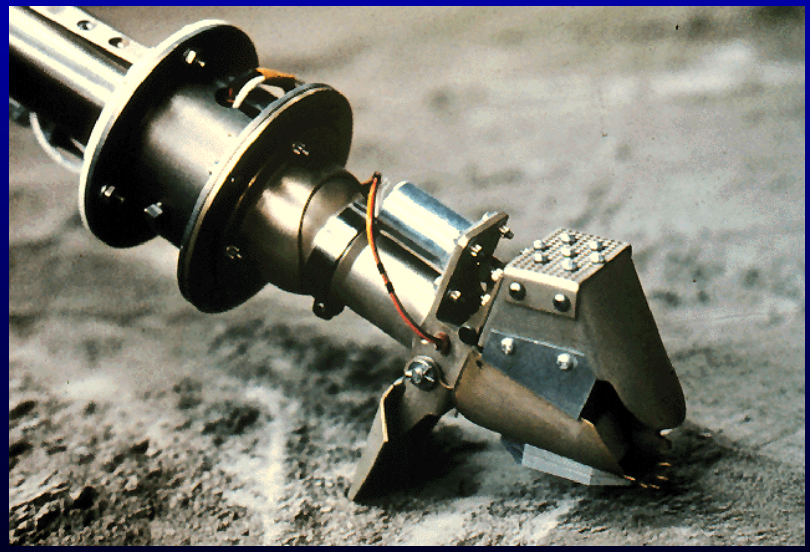
The Viking Landers

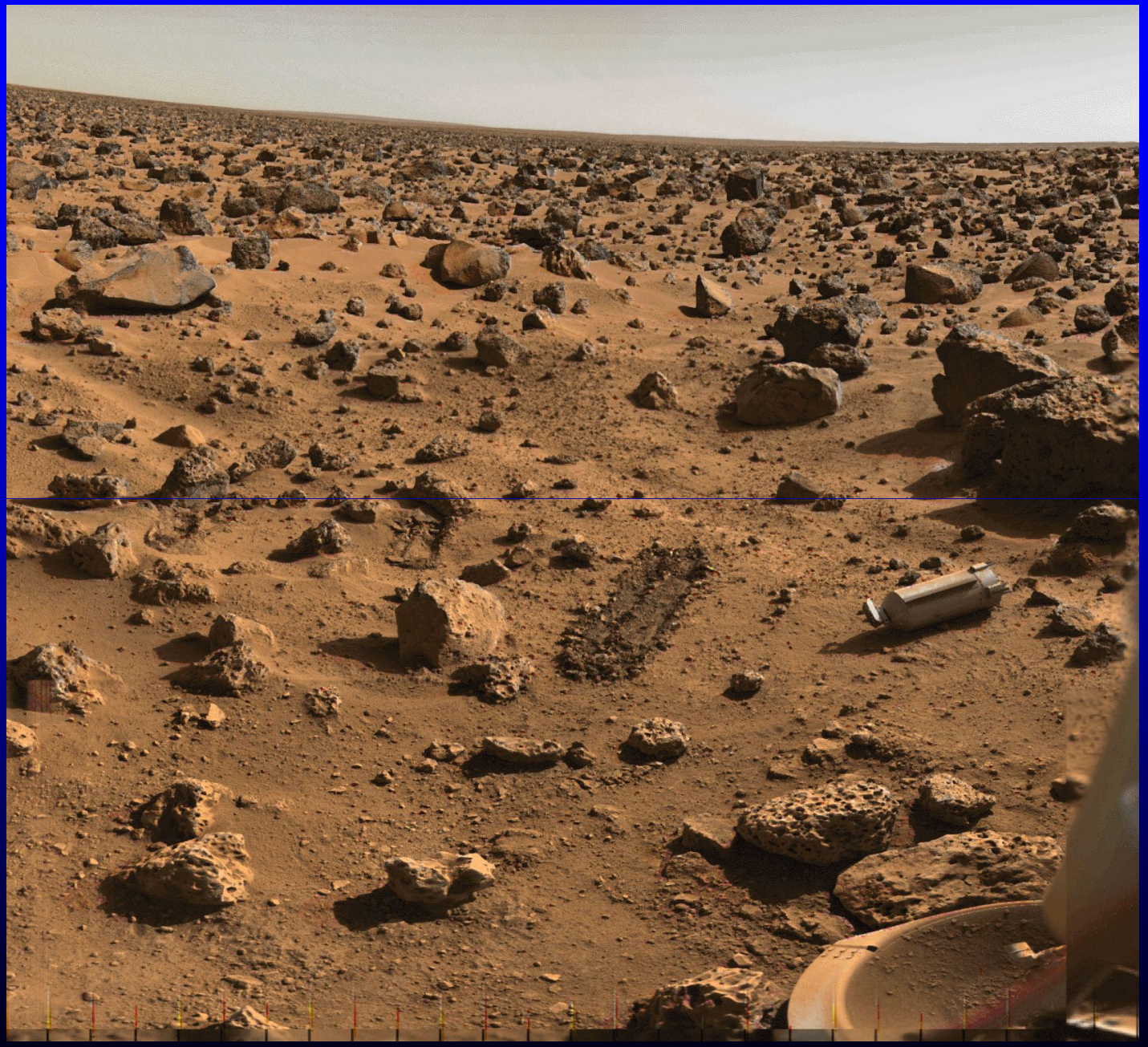
Searching for Life on Mars

First Close-up Image

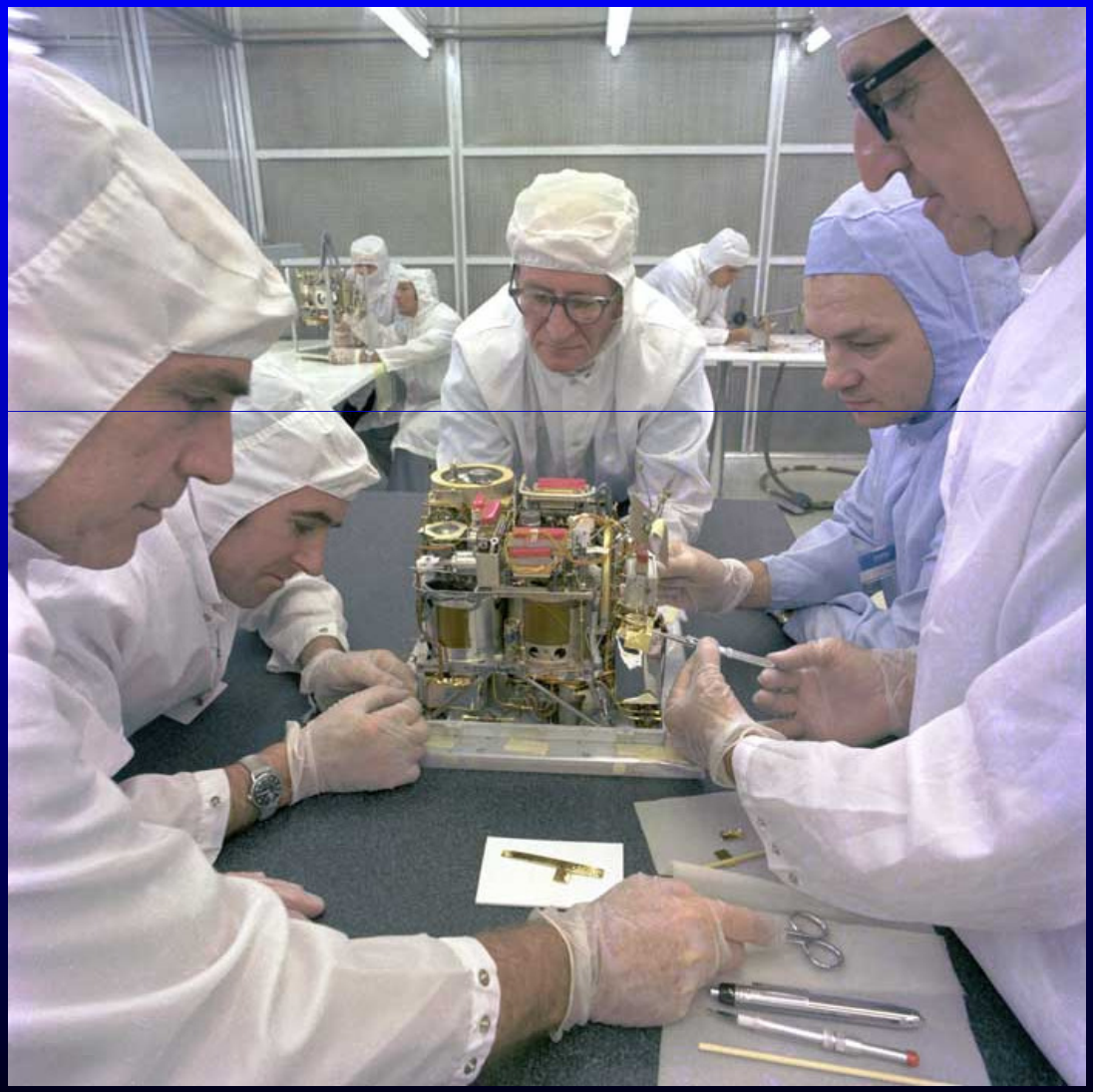


Meteorology Arm and Scoop





Viking Science package



Gas Chromatograph — Mass Spectrometer

- Found no evidence of any significant amount of organic molecules in the Martian soil. In fact, Martian soils were found to contain less carbon than lunar soils returned by the Apollo program.

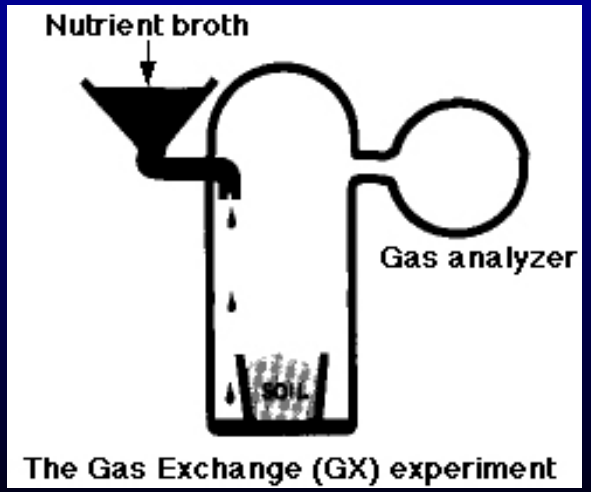
- The strongest organic concentrations it measured were minute trace contaminants brought from Earth, left over from the assembly and cleaning of the sample chambers and instruments.

Gas Exchange Experiment

- This looked for gases given off by an incubated soil sample having applied a liquid complex of organic and inorganic nutrients to a soil sample.

- The instrument then measured the concentrations of several gases, including oxygen, CO2, nitrogen, hydrogen, and methane over time.

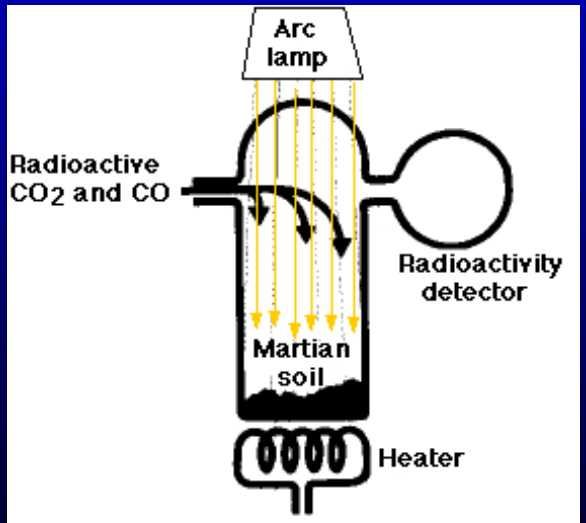
- The result was negative.



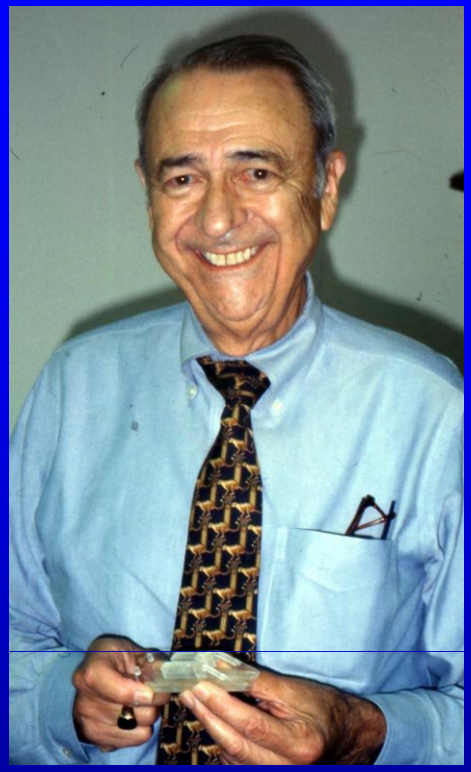
The Gas Exchange (GX) experiment

Pyrolytic Release Experiment

- Water was added to soil in an atmosphere of (radioactive) carbon monoxide (CO) and carbon dioxide (CO2), simulating that on Mars.
- After several days of incubation, the experiment removed the gases, baked the remaining soil at 650 °C and collected the products in a device which counted radioactivity.
- The result was negative.

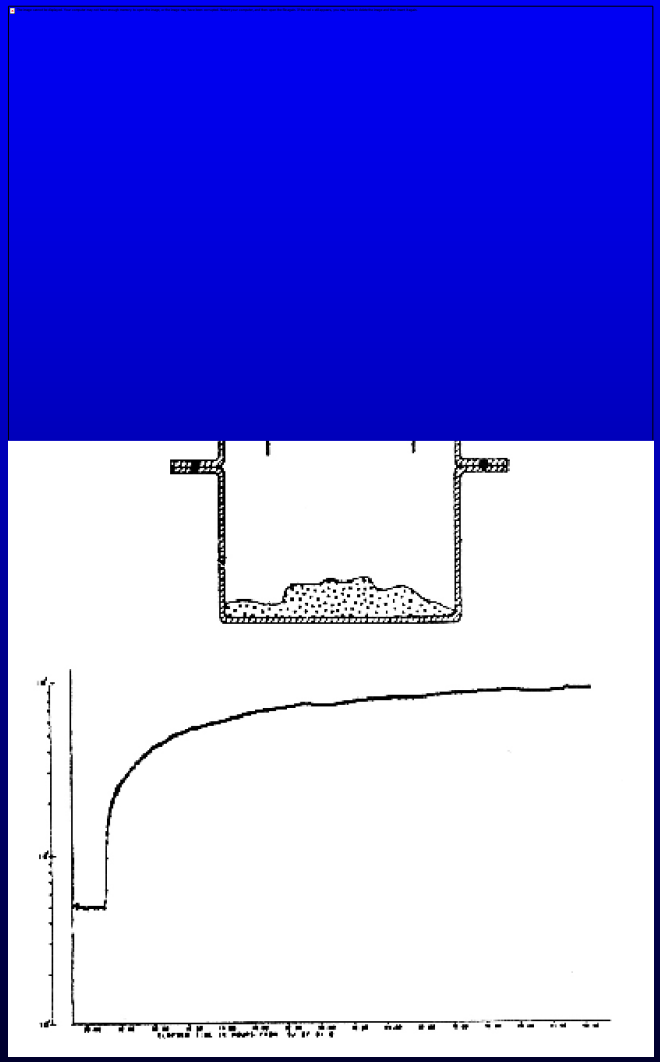


The Pyrolytic Release (PR) experiment



Gil Levin

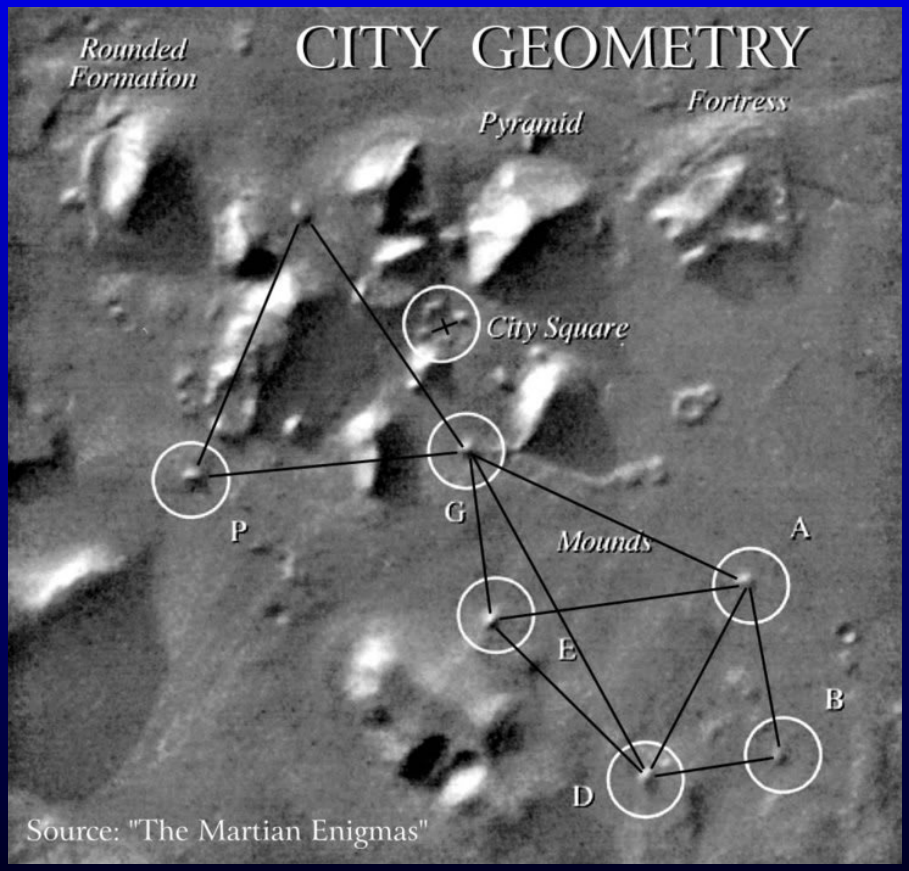
Labelled Release

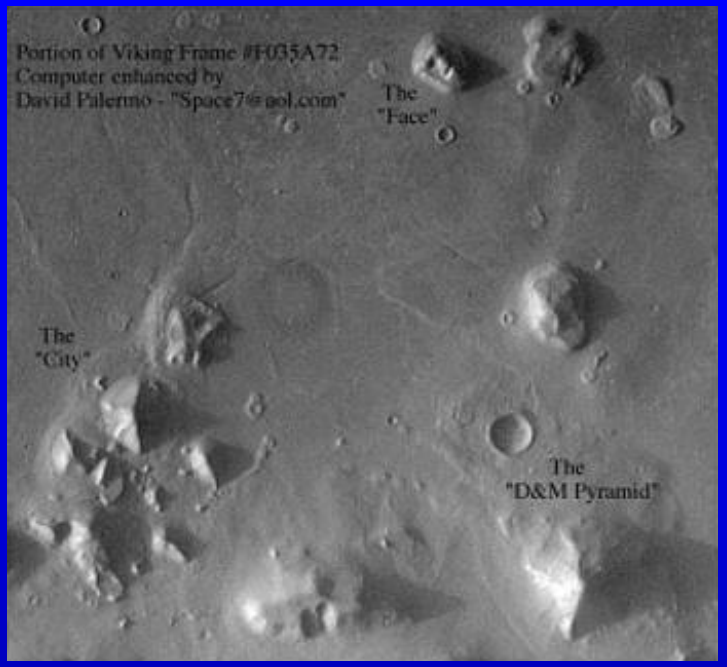


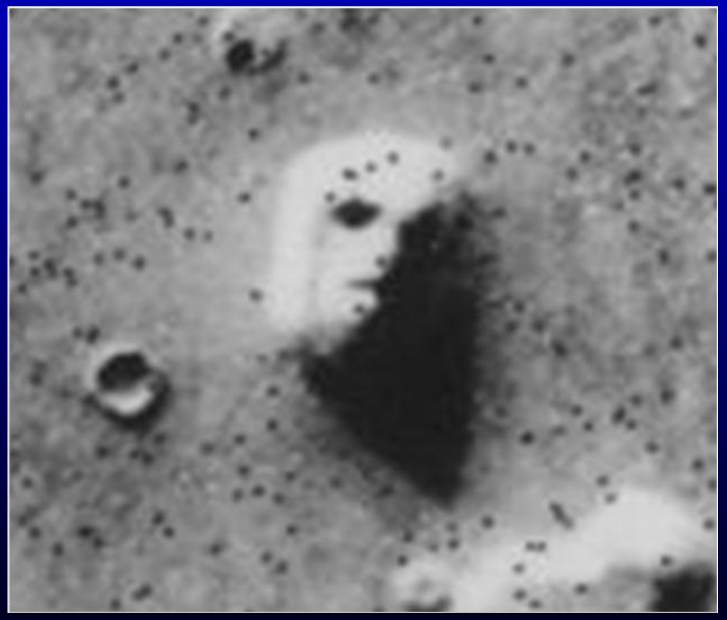
A Postscript

- 32 years later, the Phoenix Lander detected Perchlorate in the soil that could have been the cause of the observed reaction.

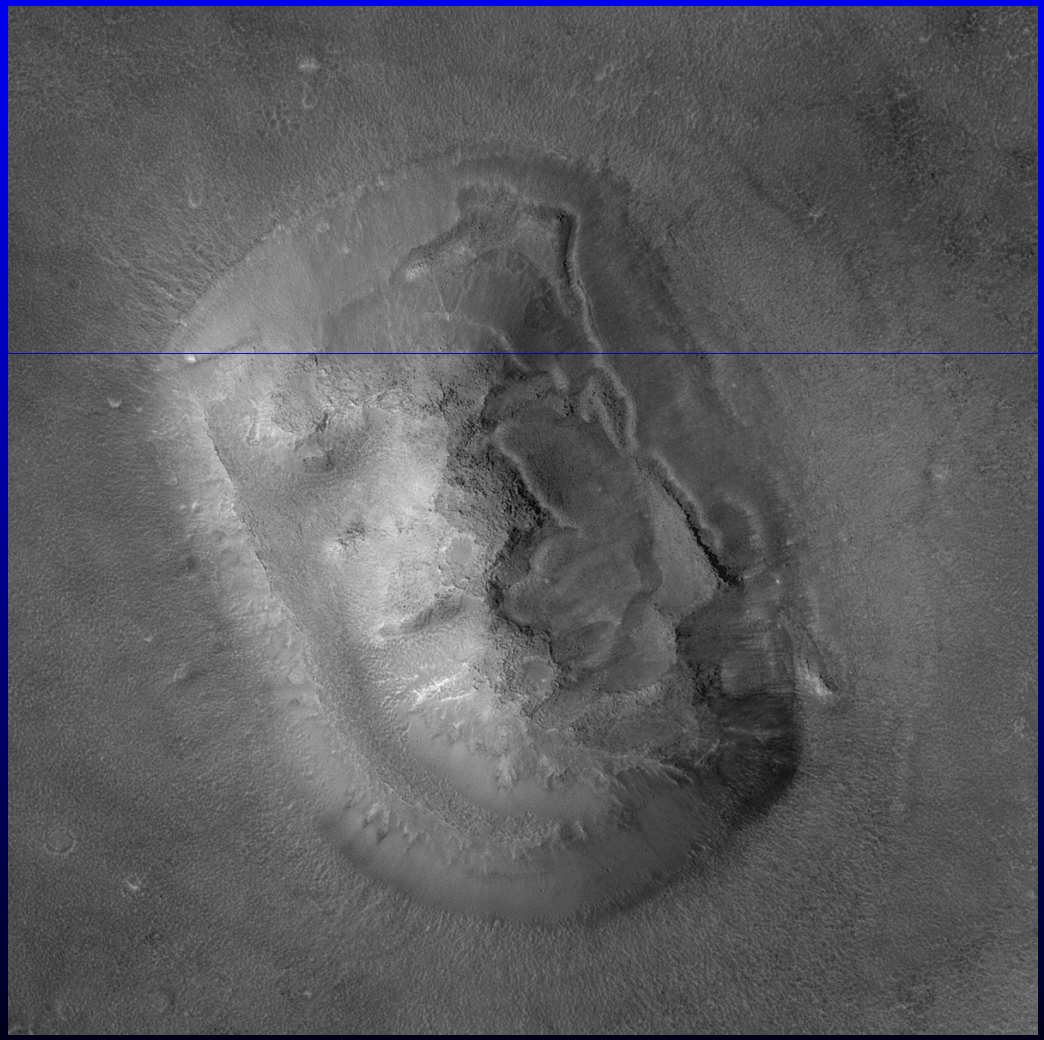
The City and Face on Mars!



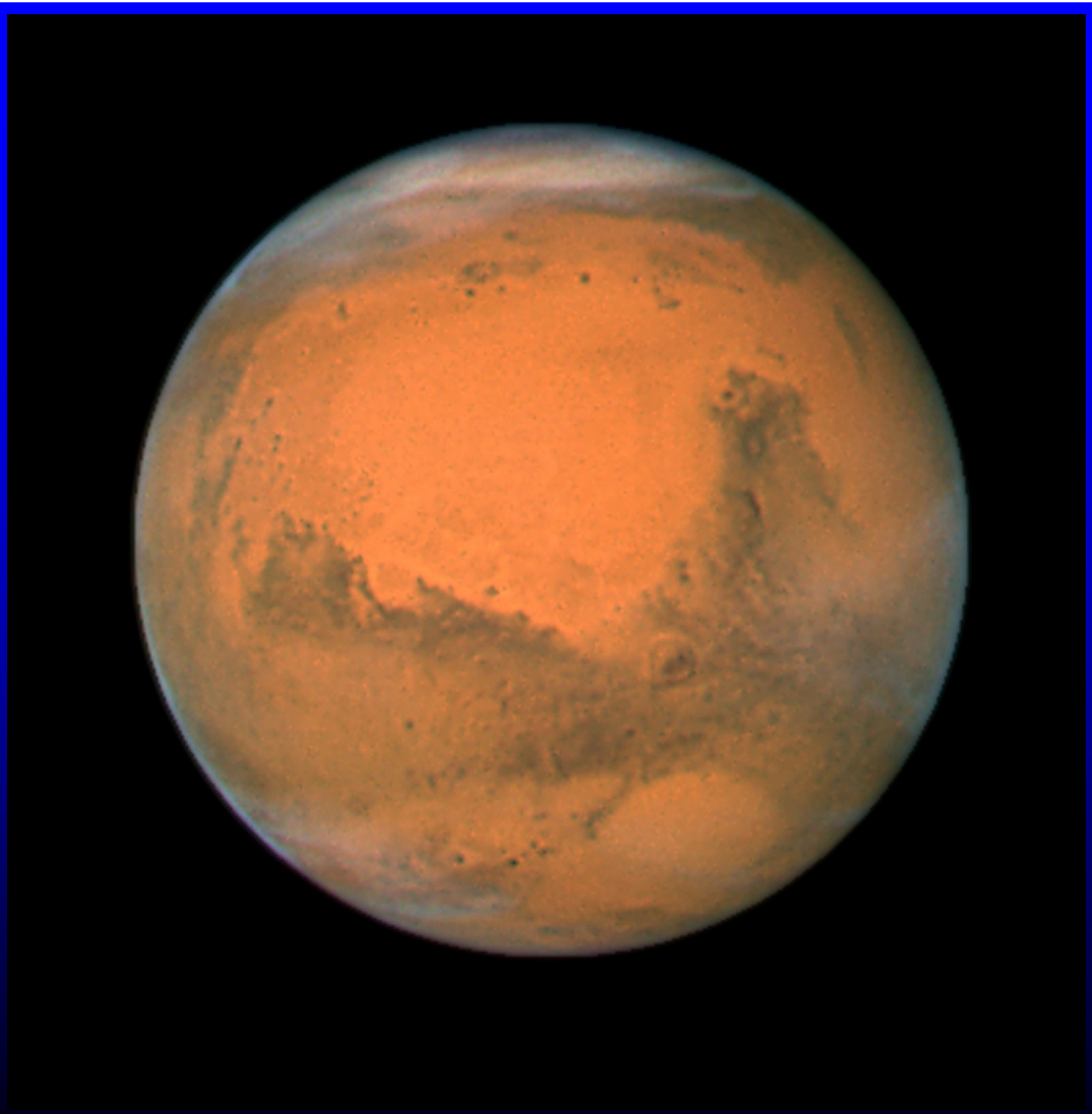


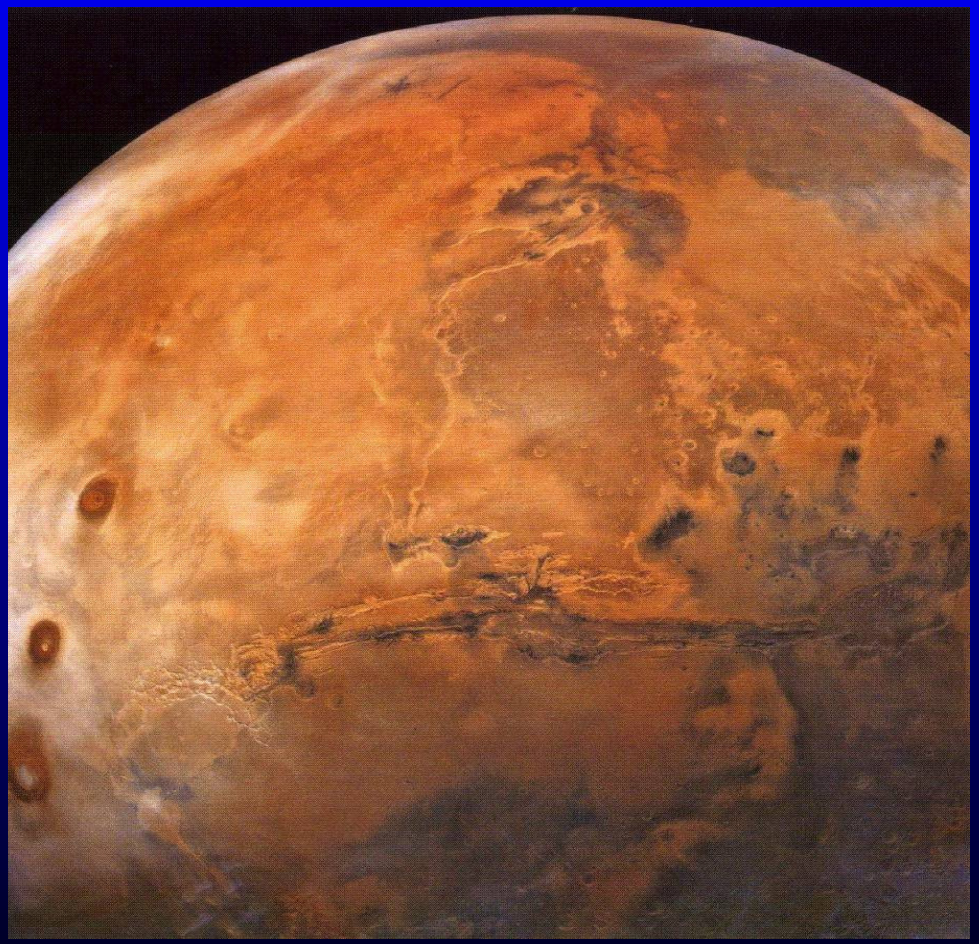


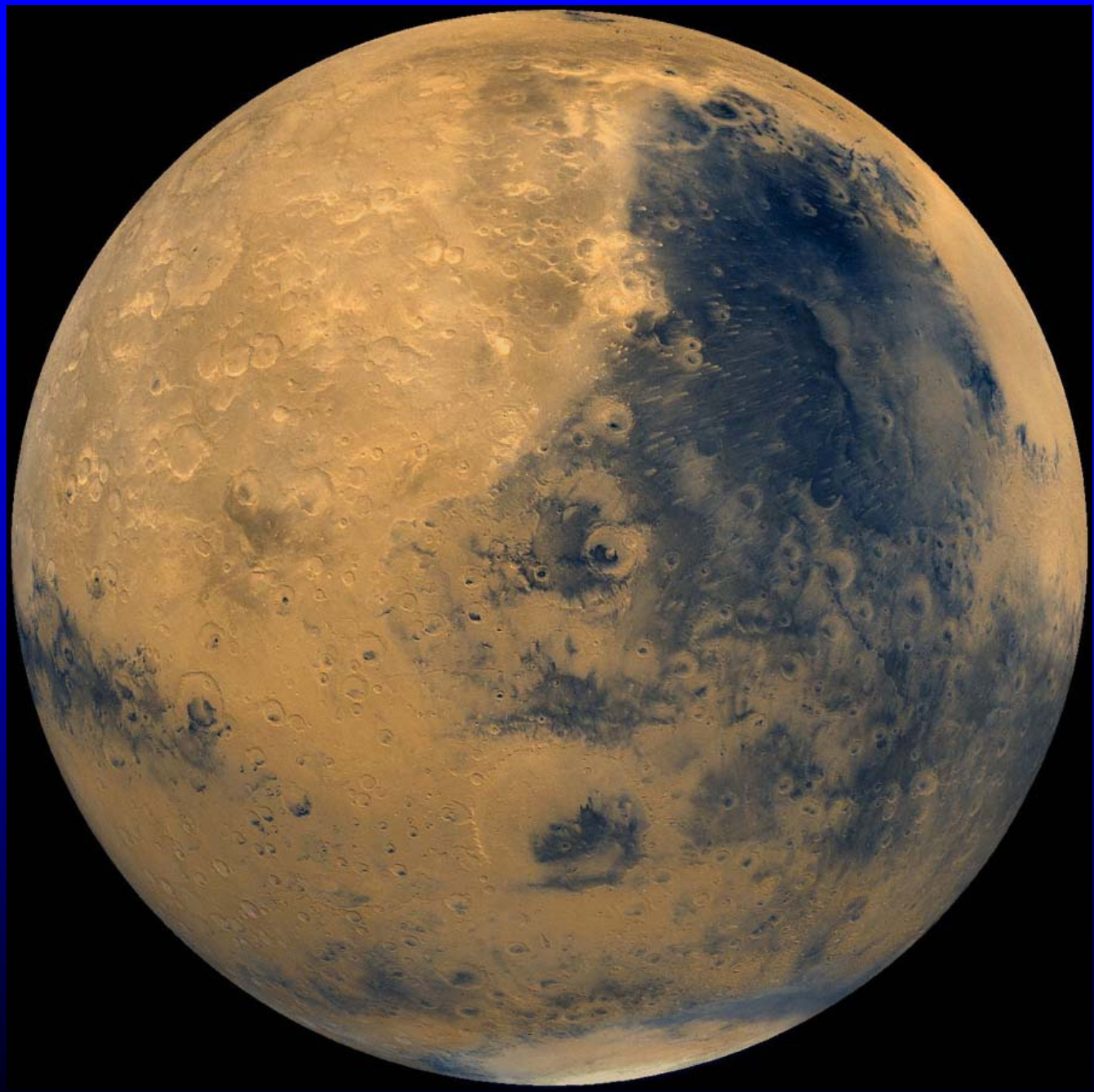
A Mesa!

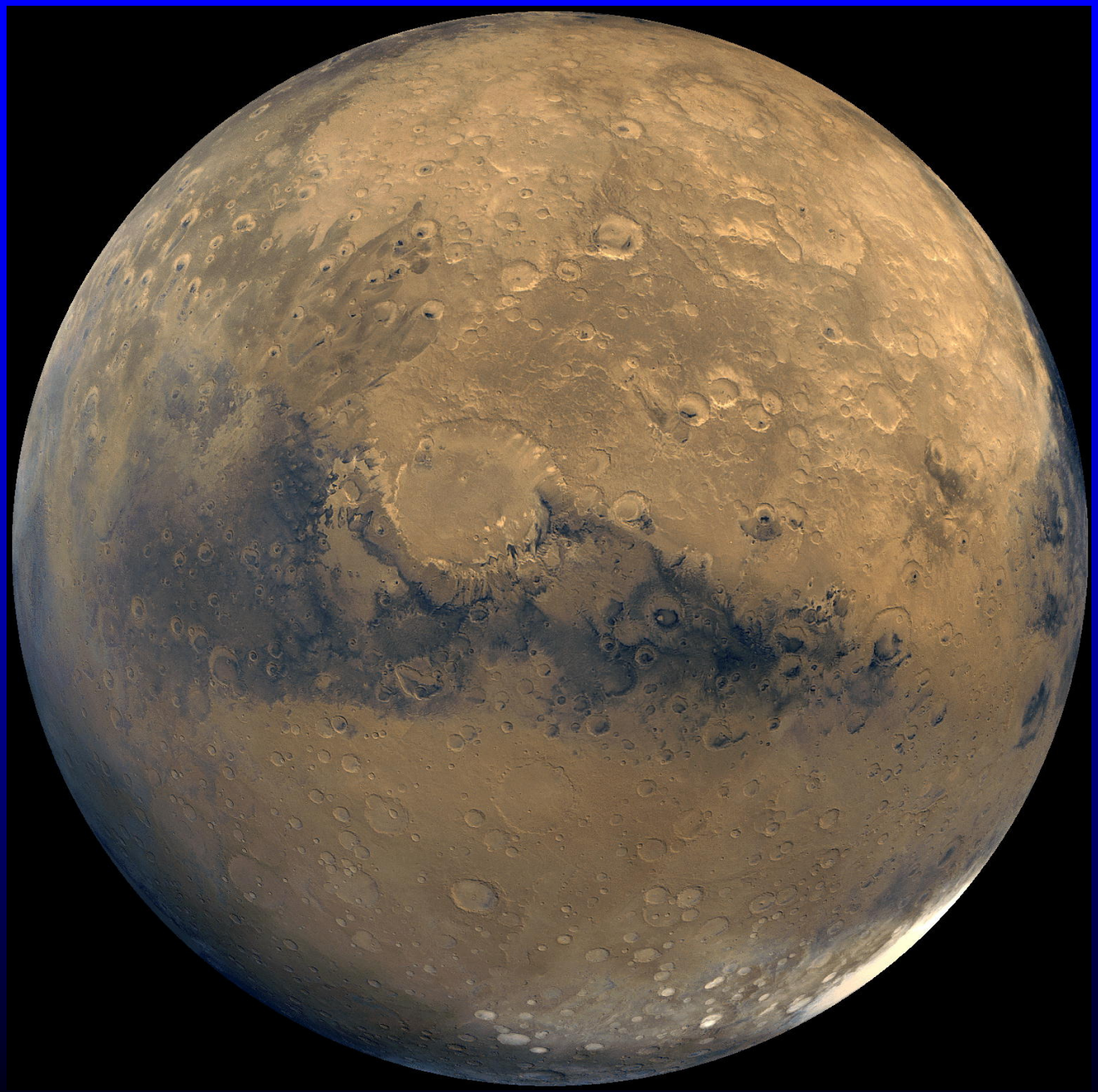


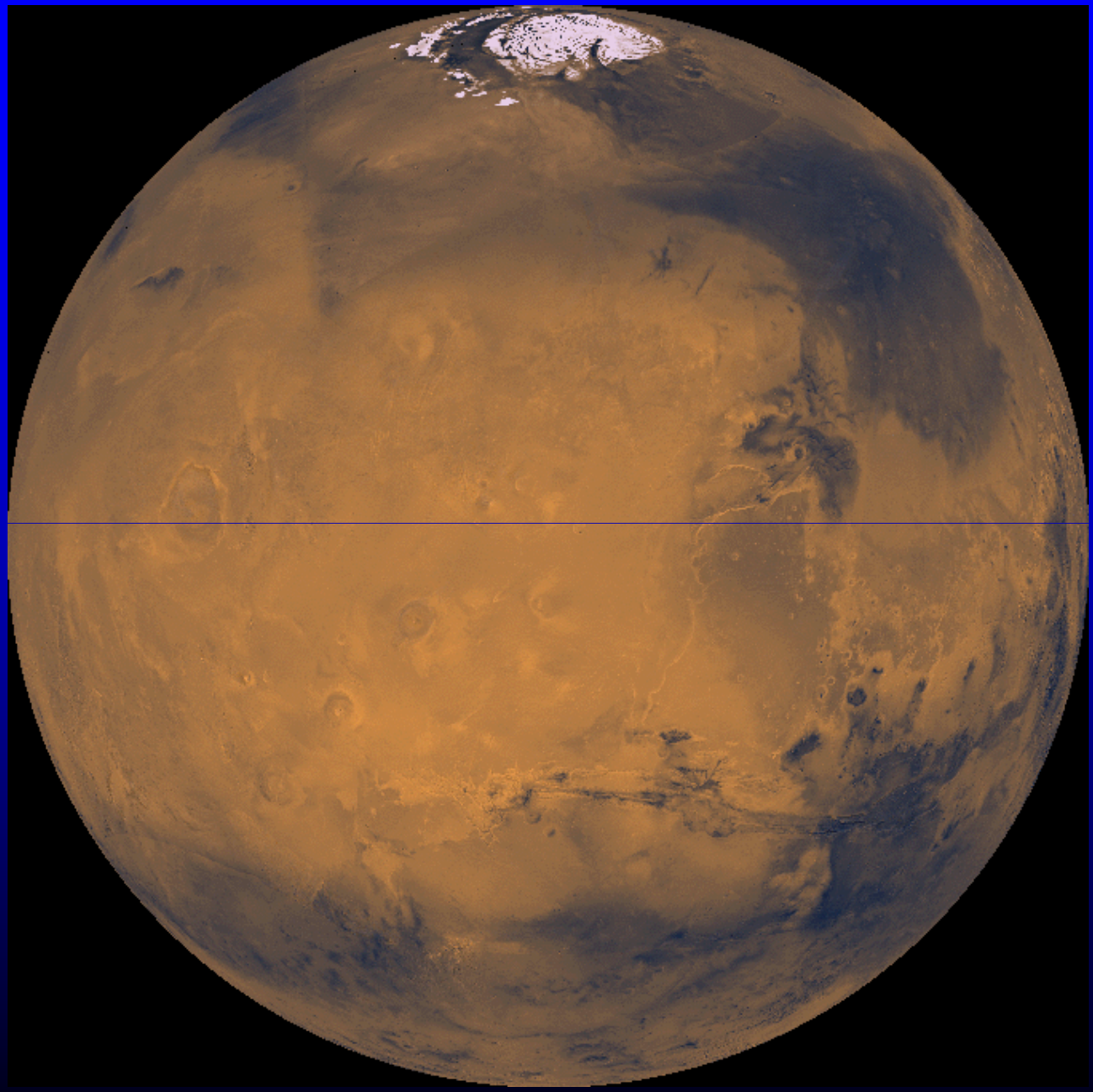
The Beauty of Mars

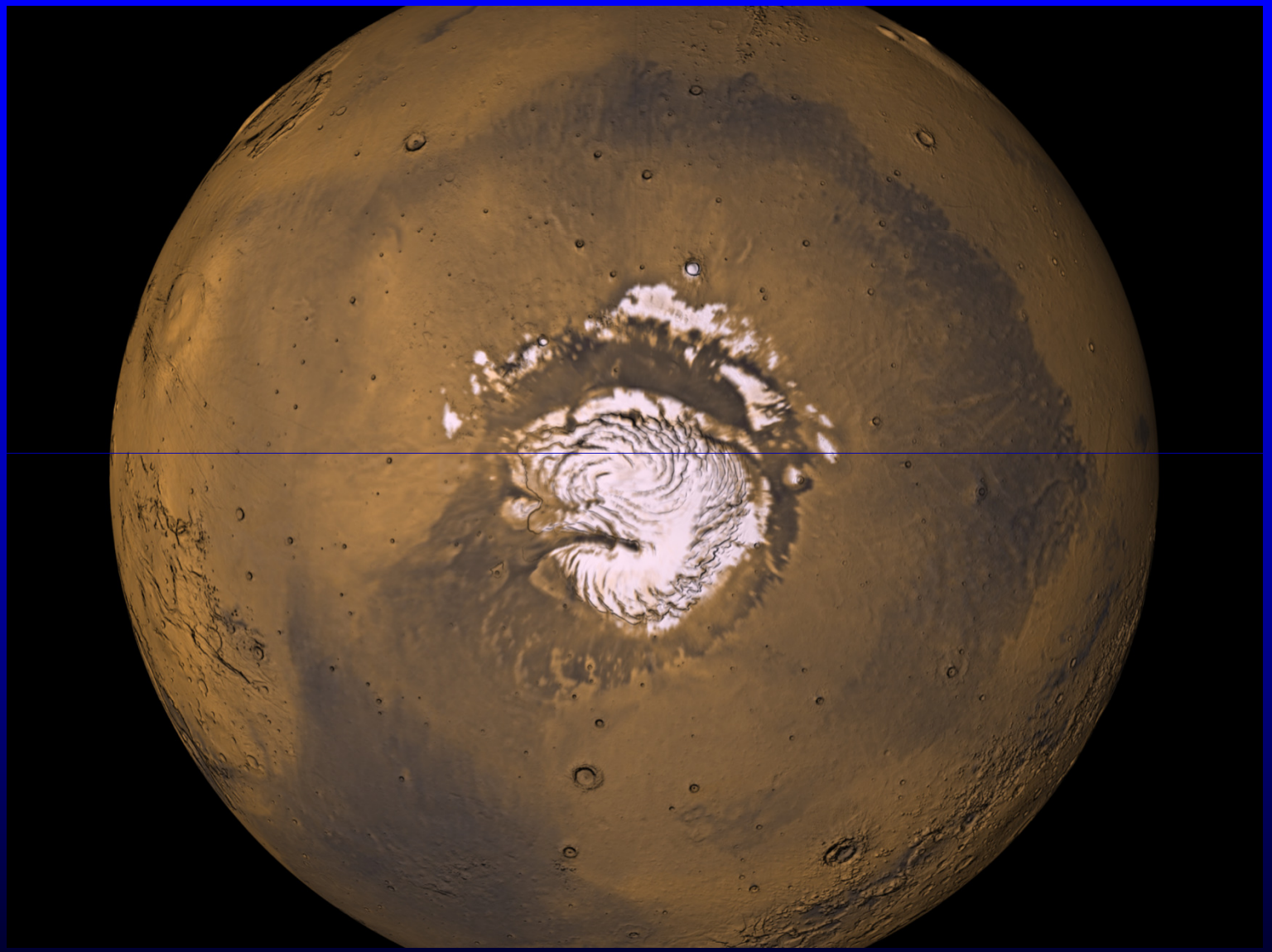


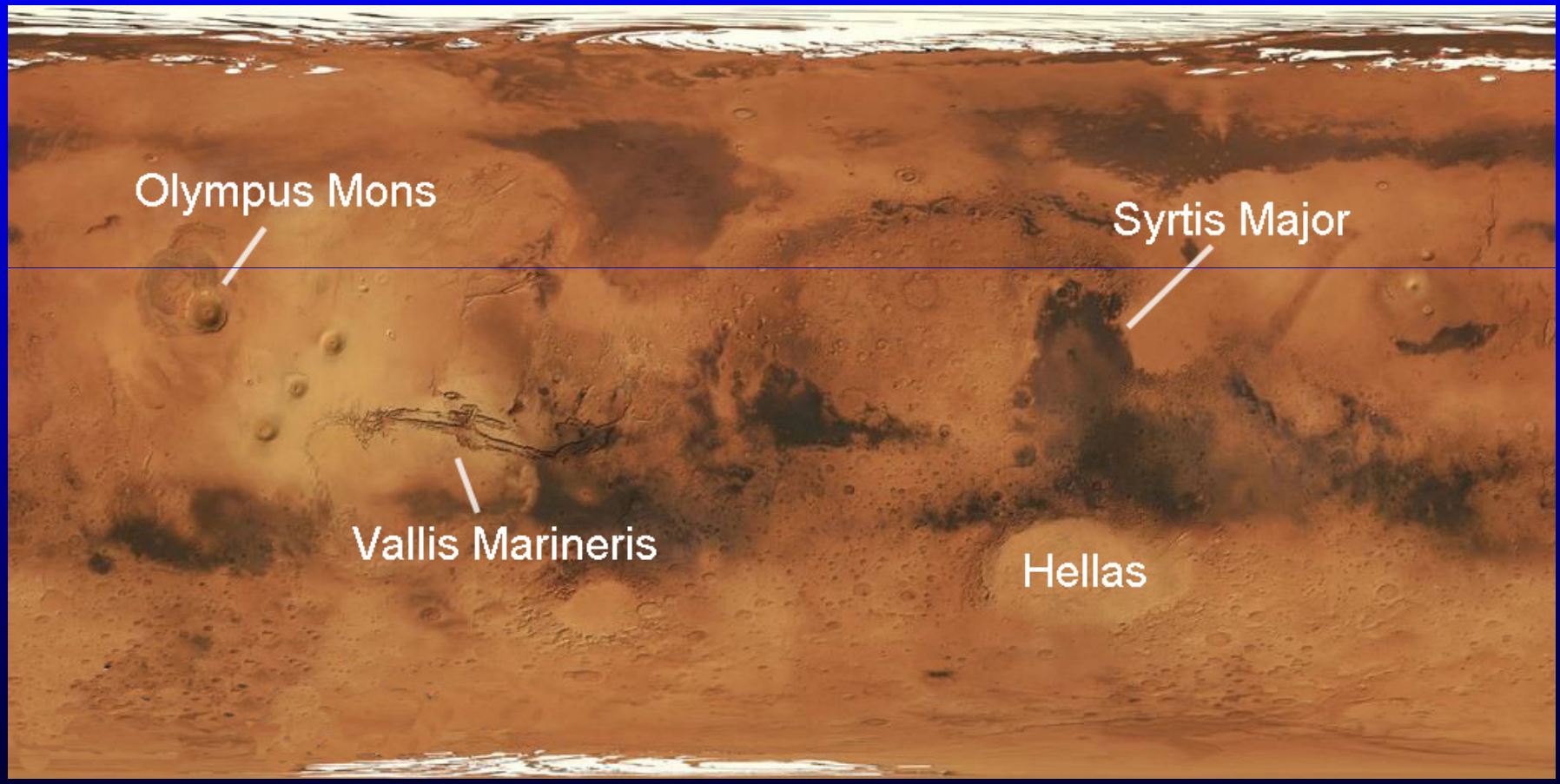




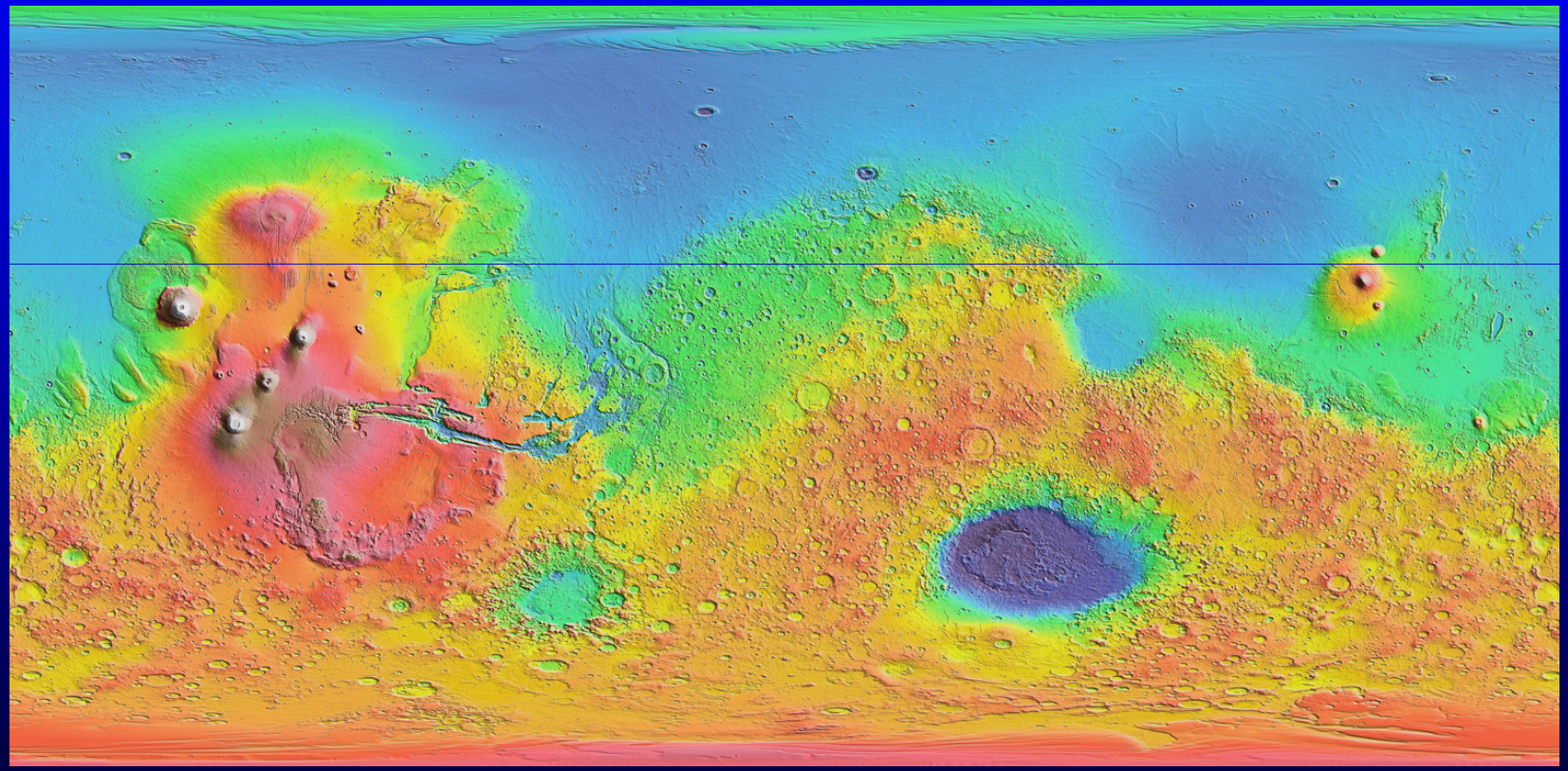


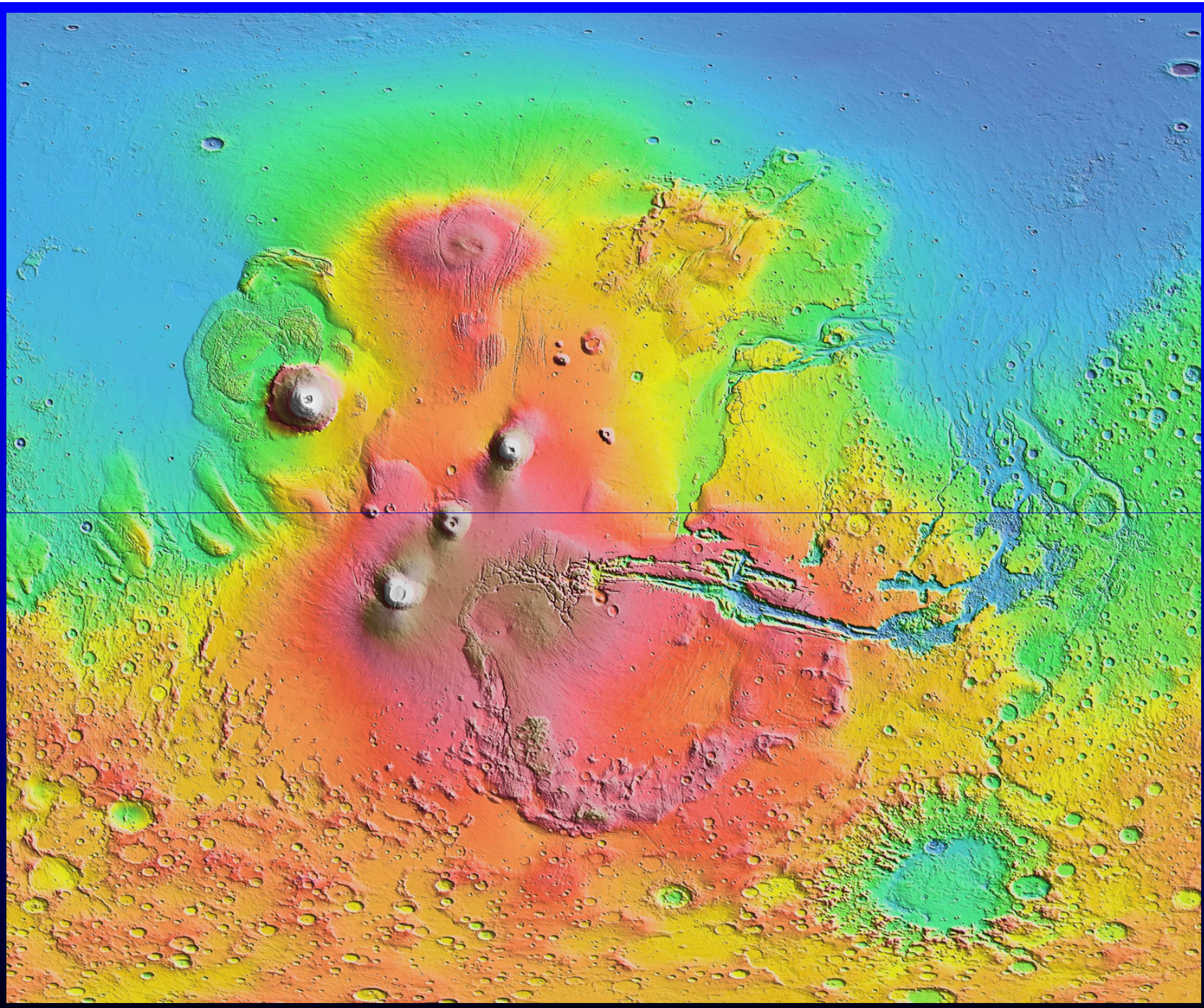




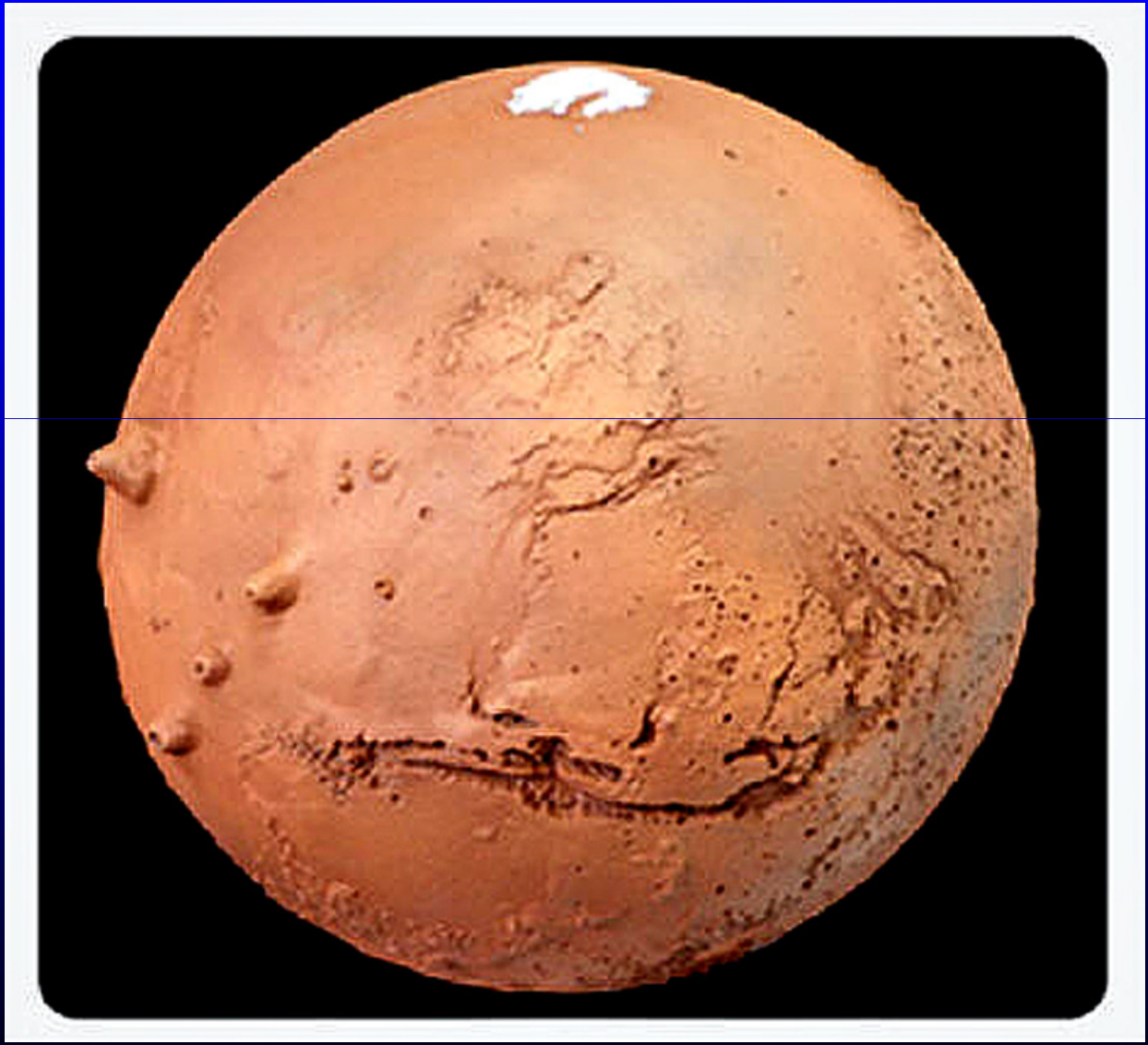

Olympus Mons
Syrtis Major
Vallis Marineris
Hellas

Mars Relief Map

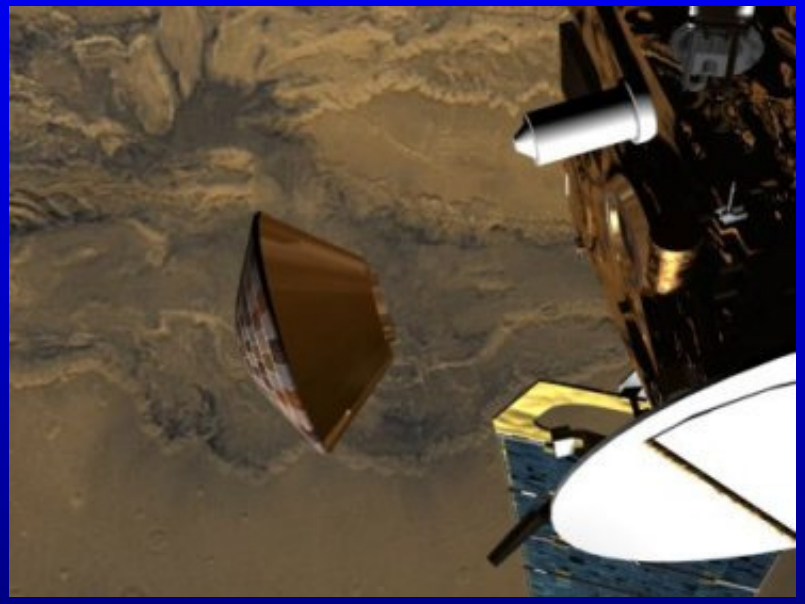




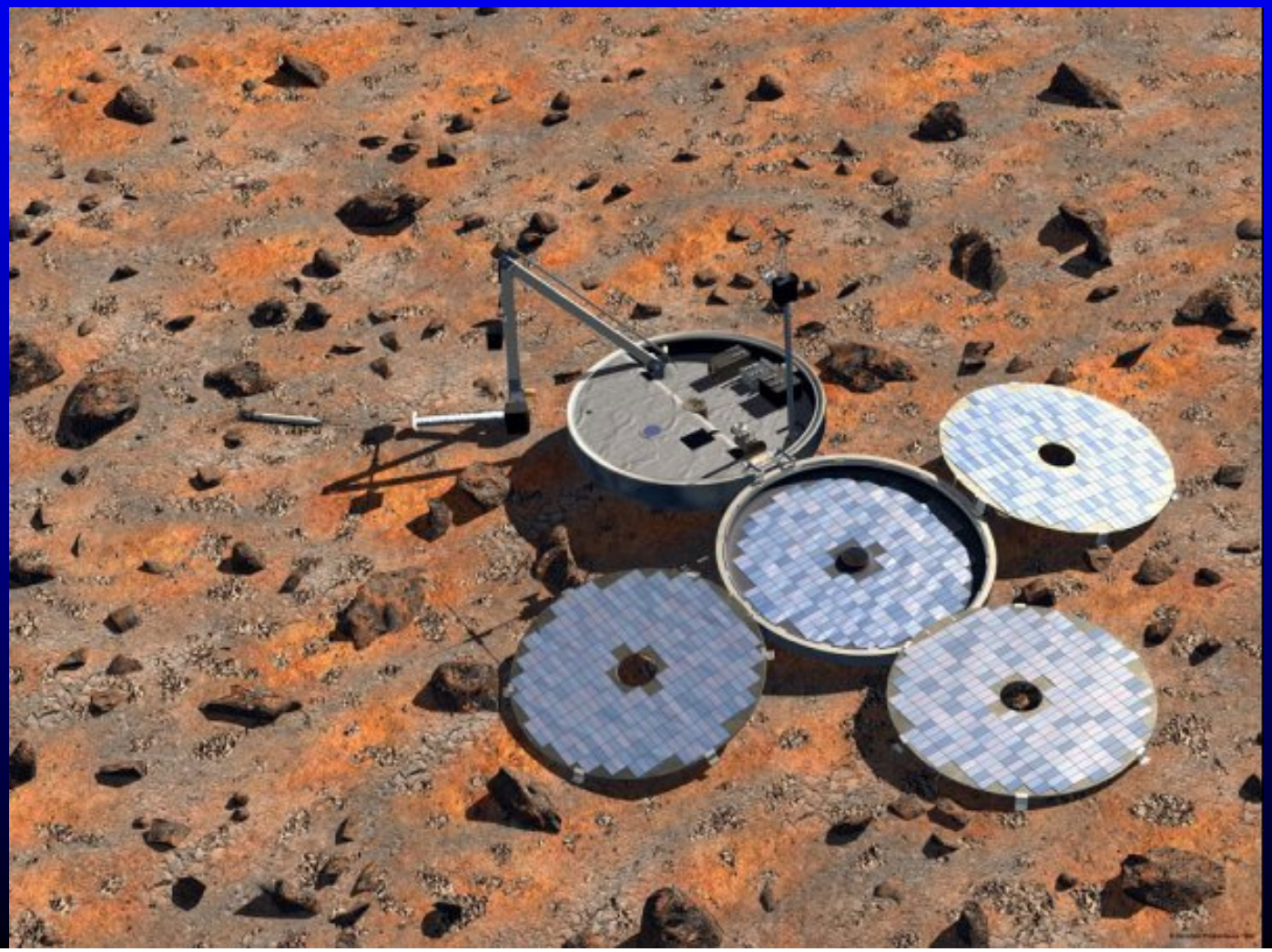
20x Relief Globe



Beagle II – a sad ending!

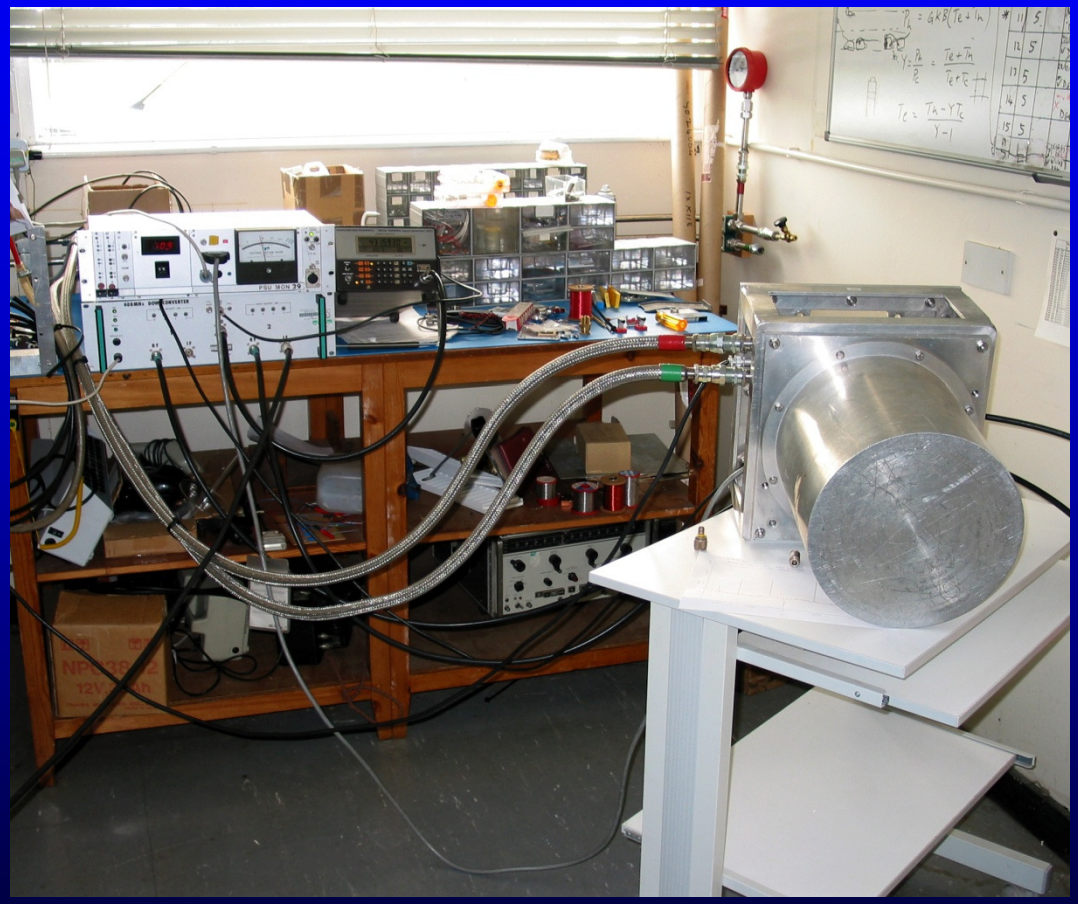


Beagle II would have looked for evidence of Life.



Cryogenic 401MHz Receiver

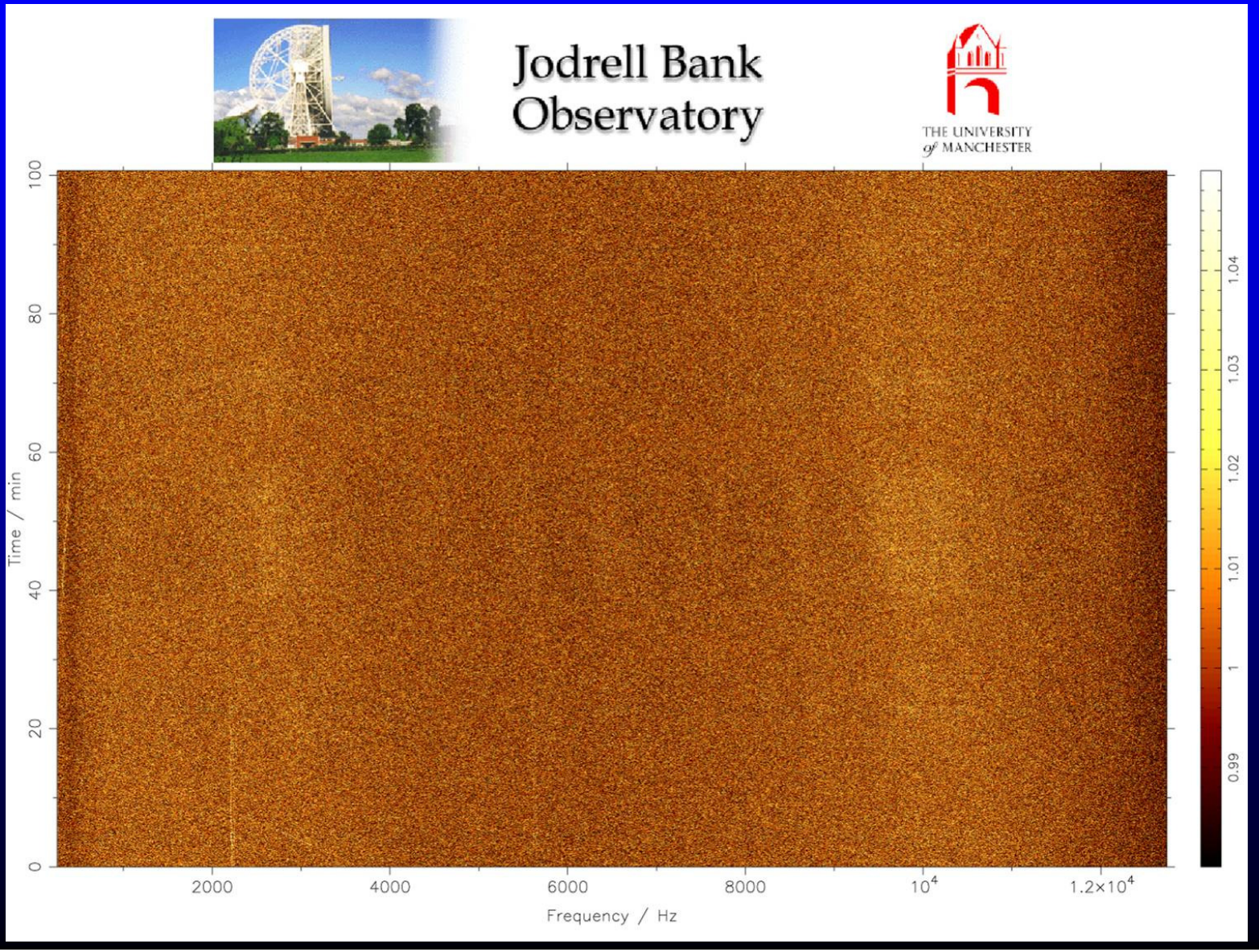
- Cooled to -260 C (13 K)
- Contained high-temperature superconducting filters to eliminate terrestrial interference



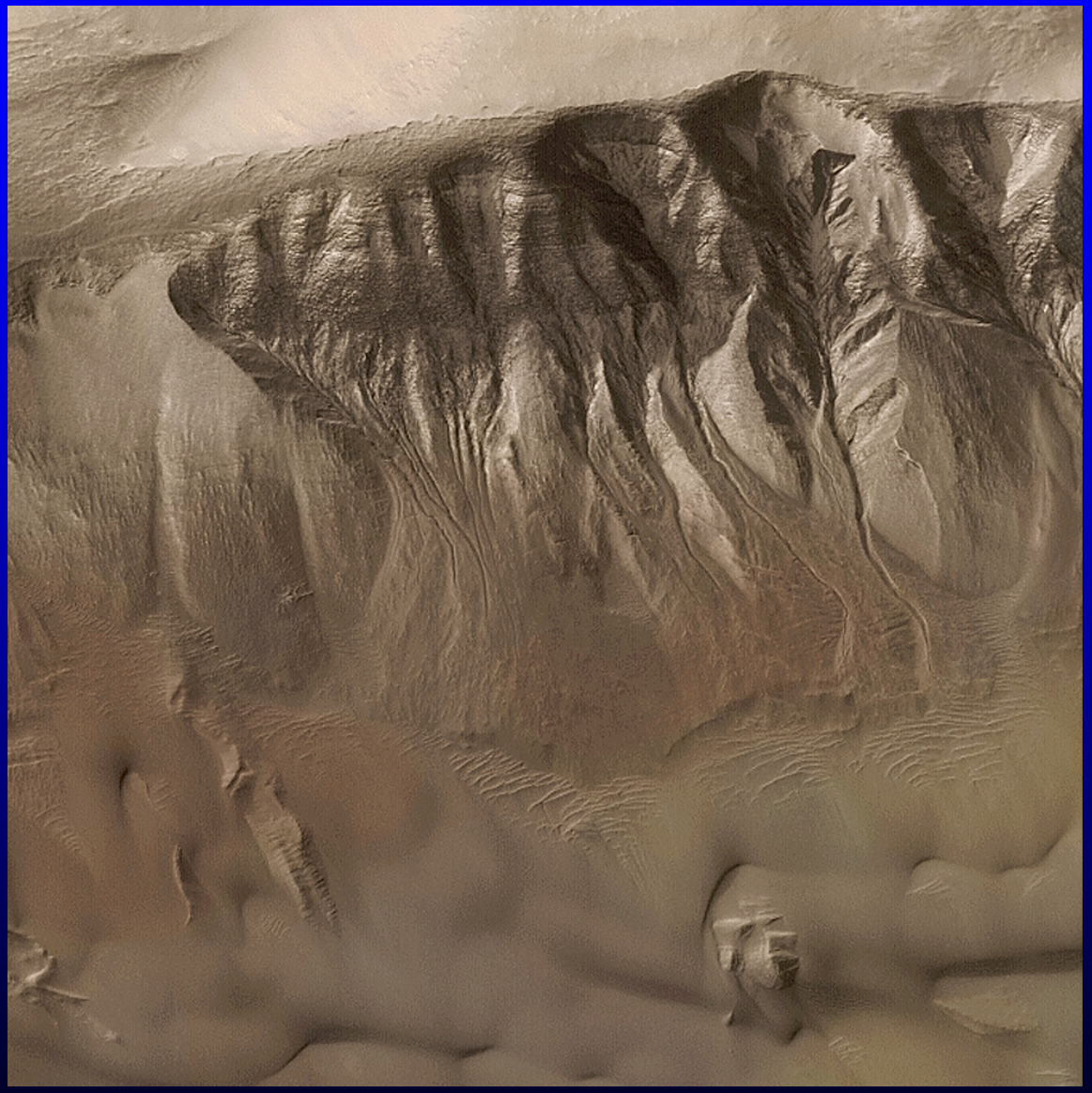
Lovell Telescope Observations

- 25/26/27/28 December
- 23/24/25 January
- Whilst Beagle 2 landing site was visible from Jodrell Bank

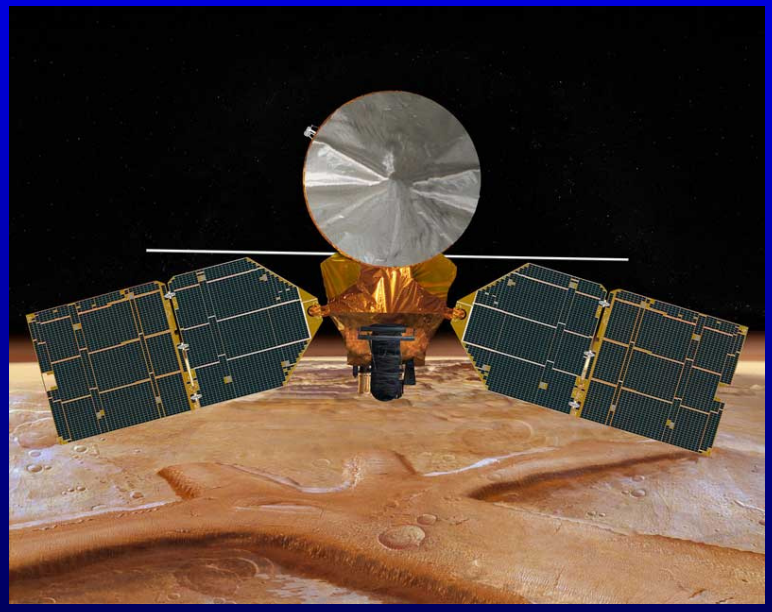
Waterfall Display

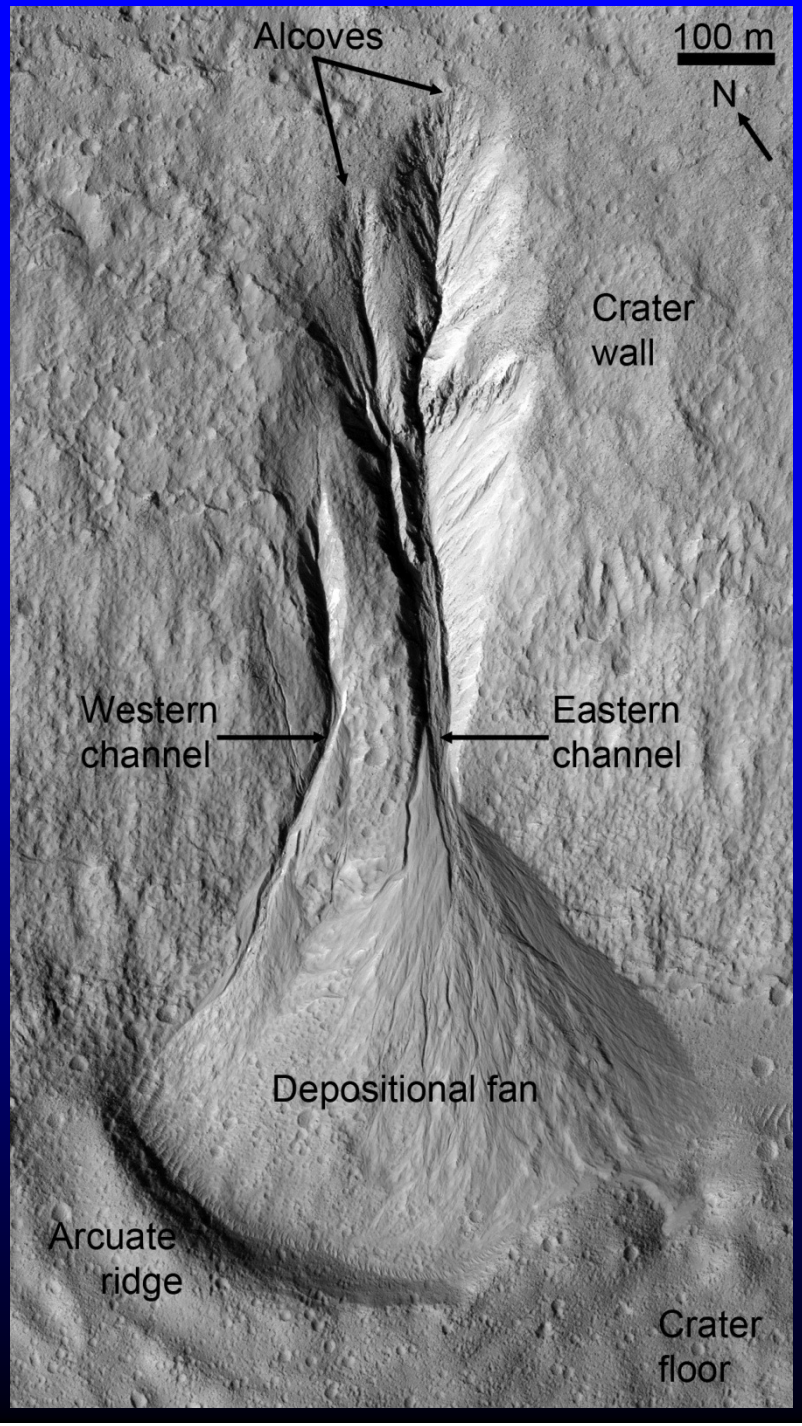


Mars Global Surveyor



Mars Reconaisance Orbiter

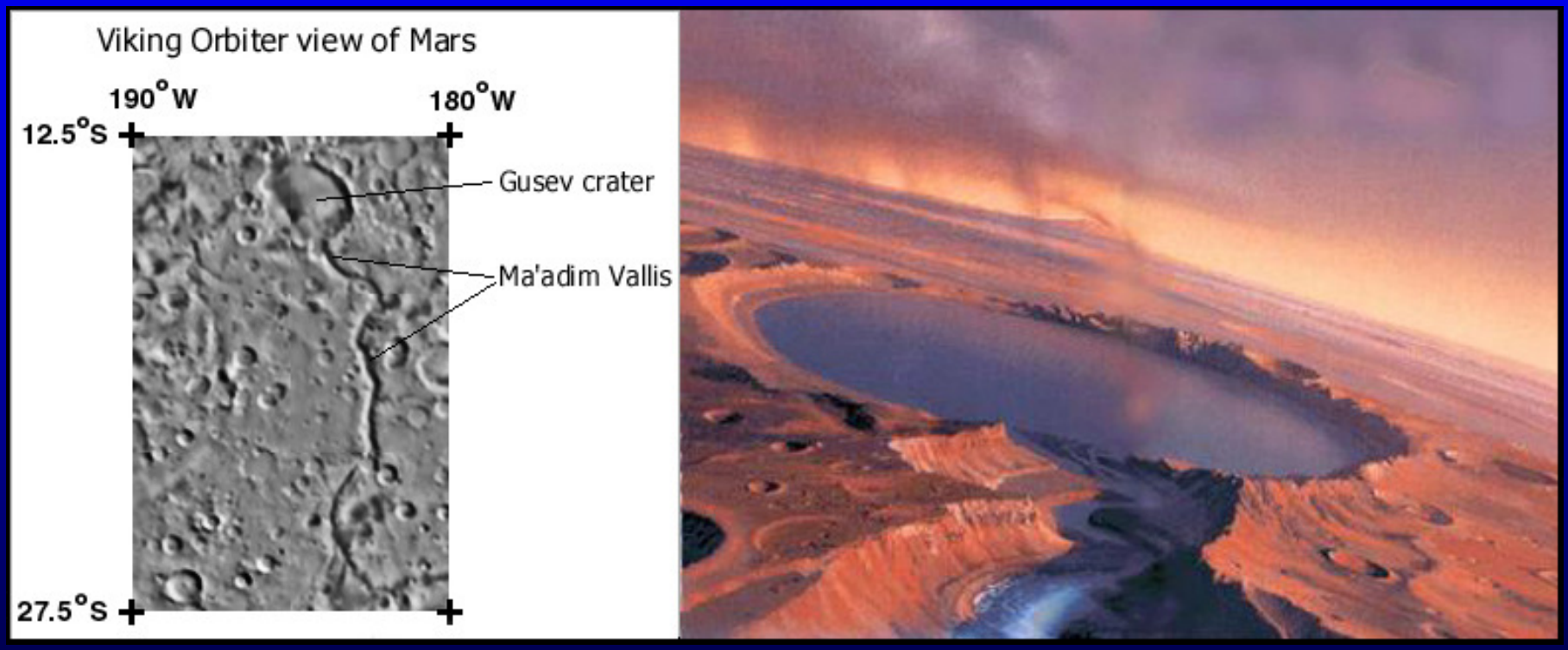


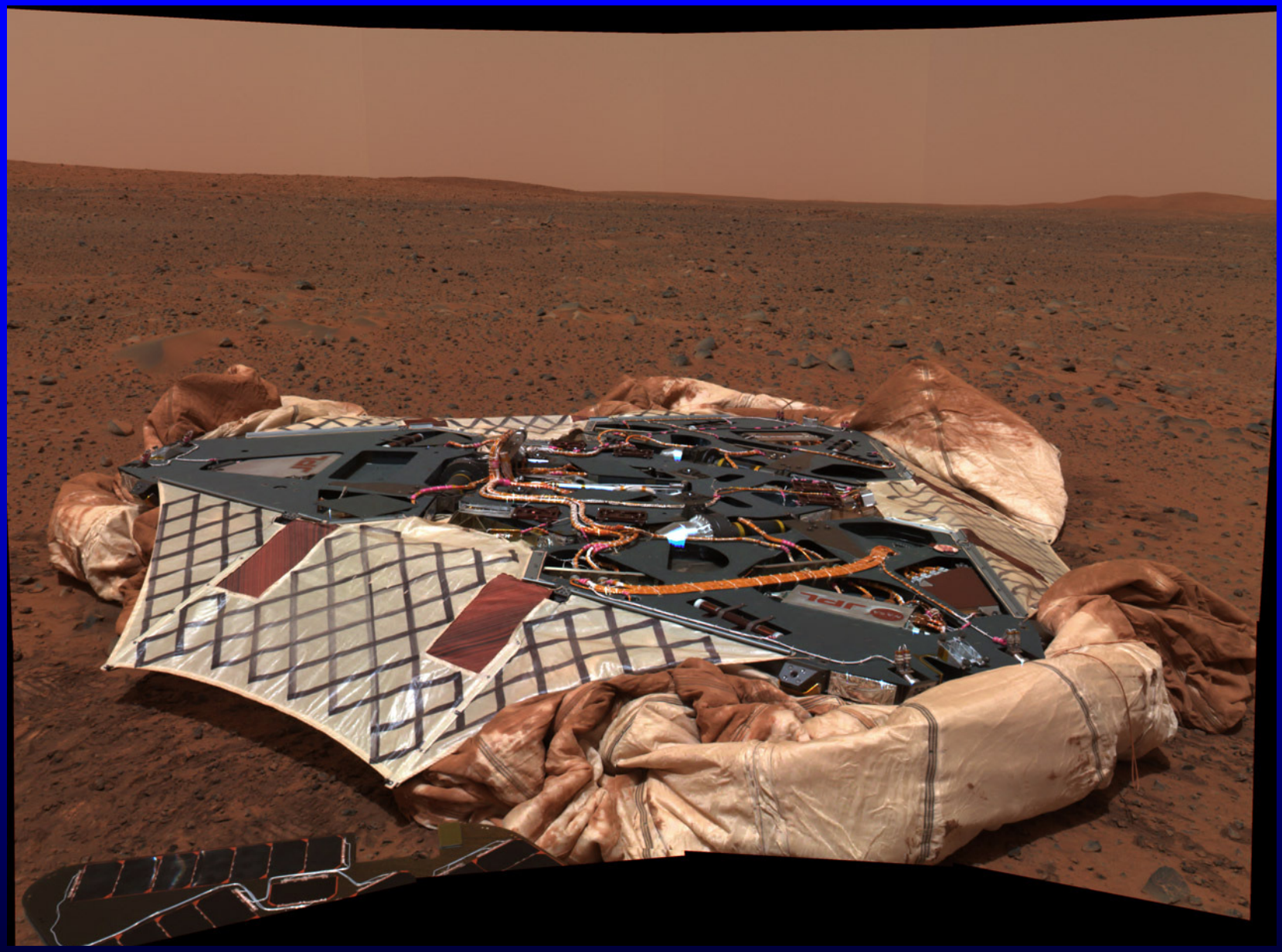


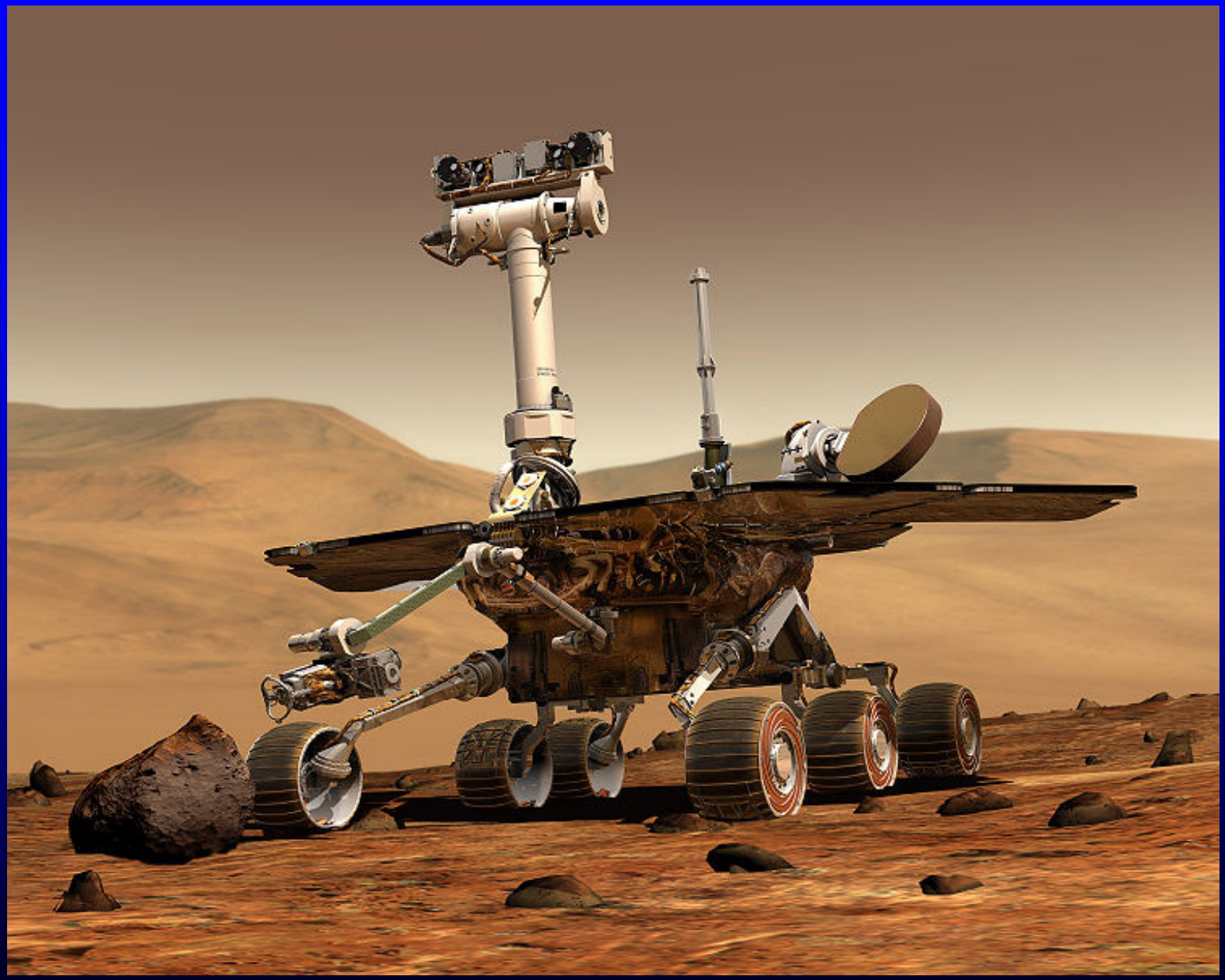
Spirit and Opportunity

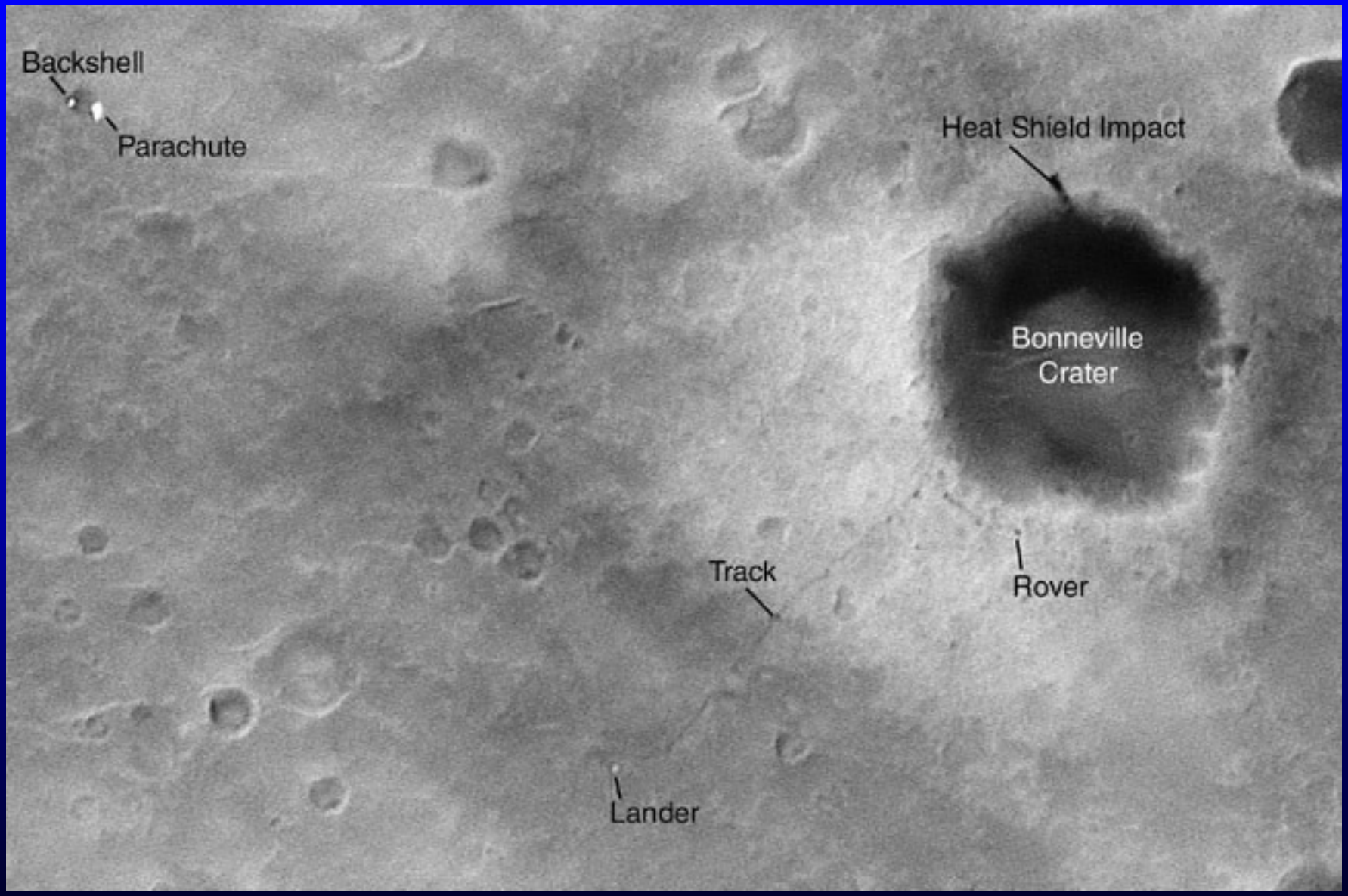
Miracles of Technology!

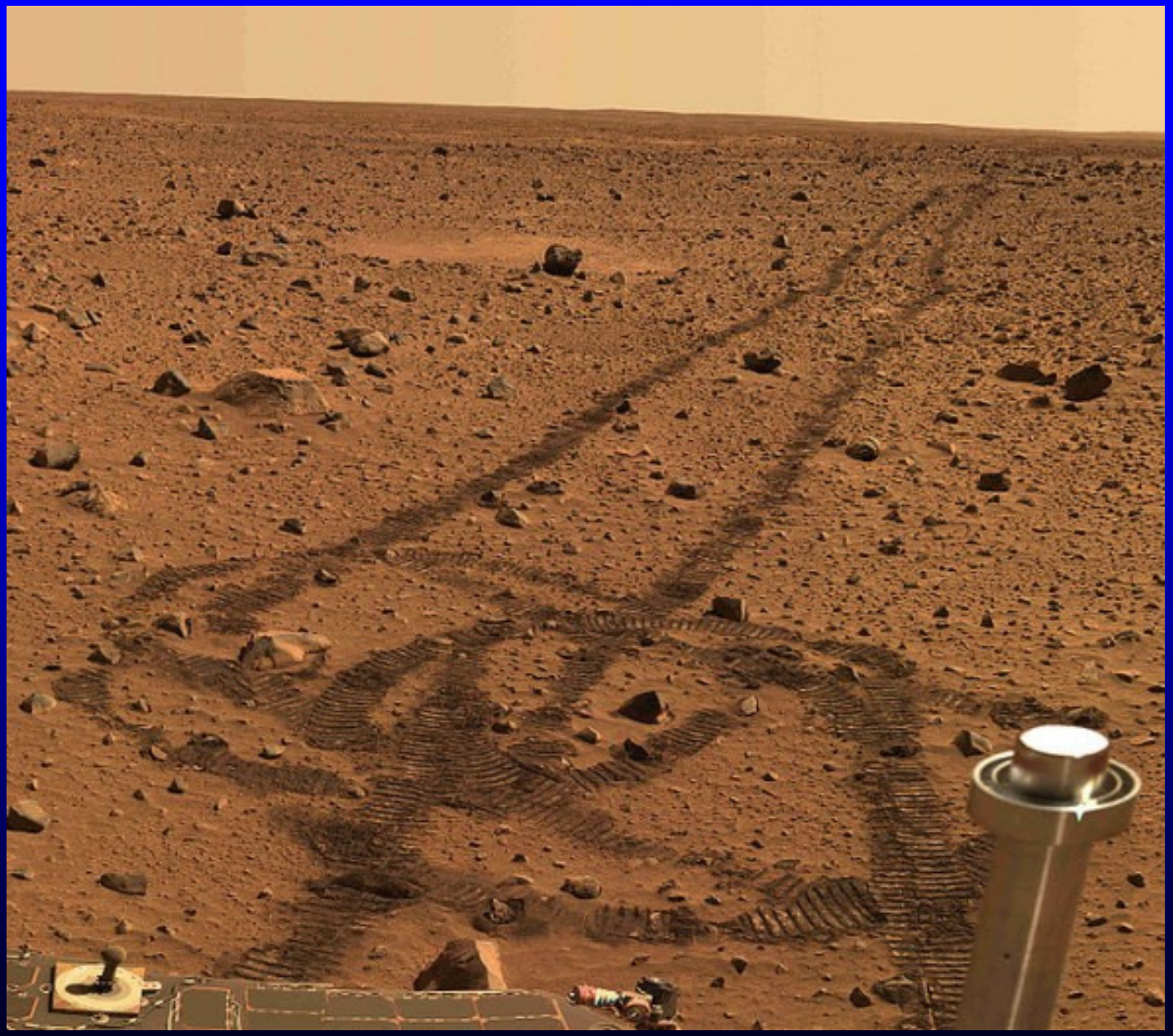
Spirit landed in Gusev Crater

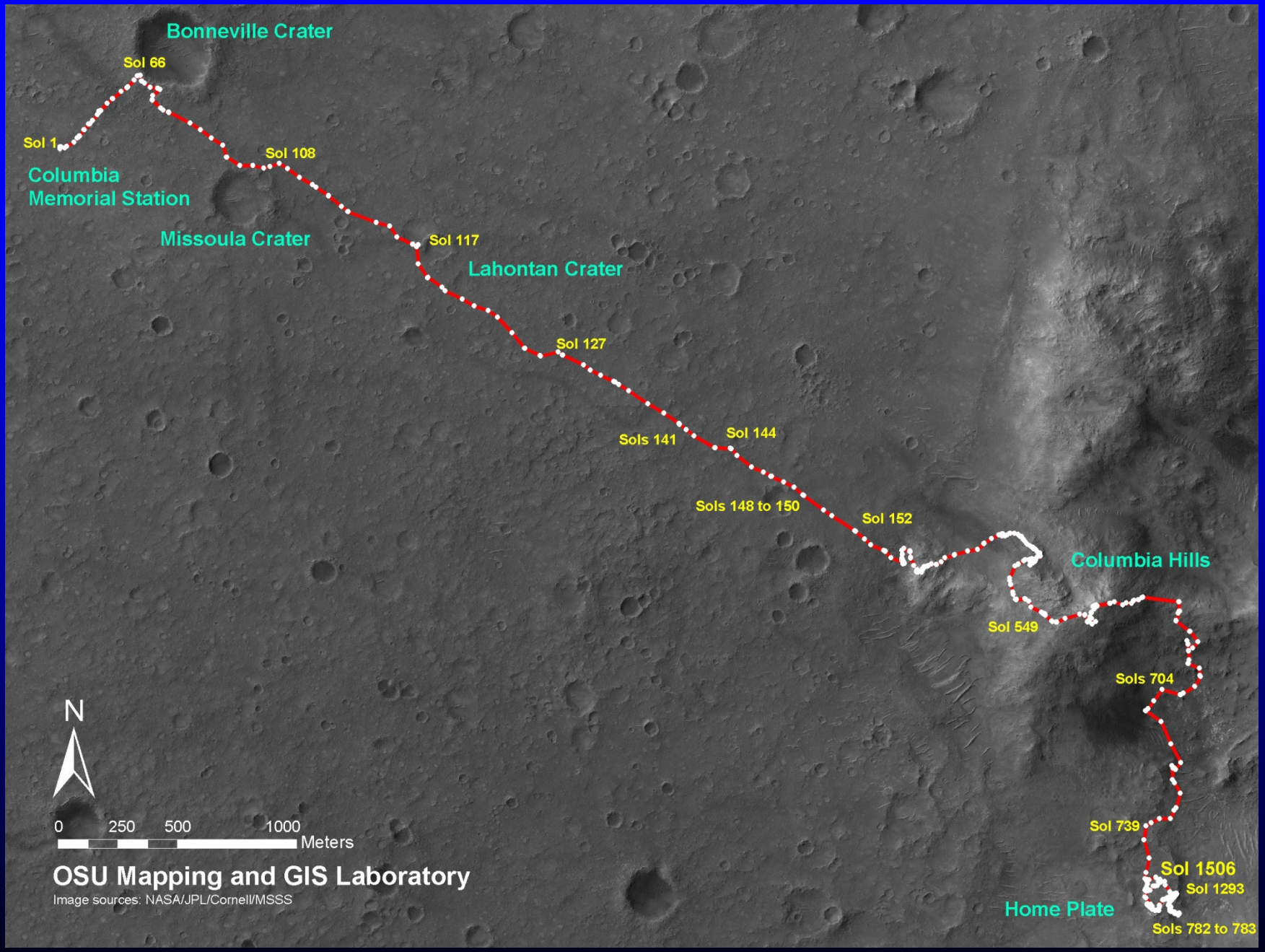


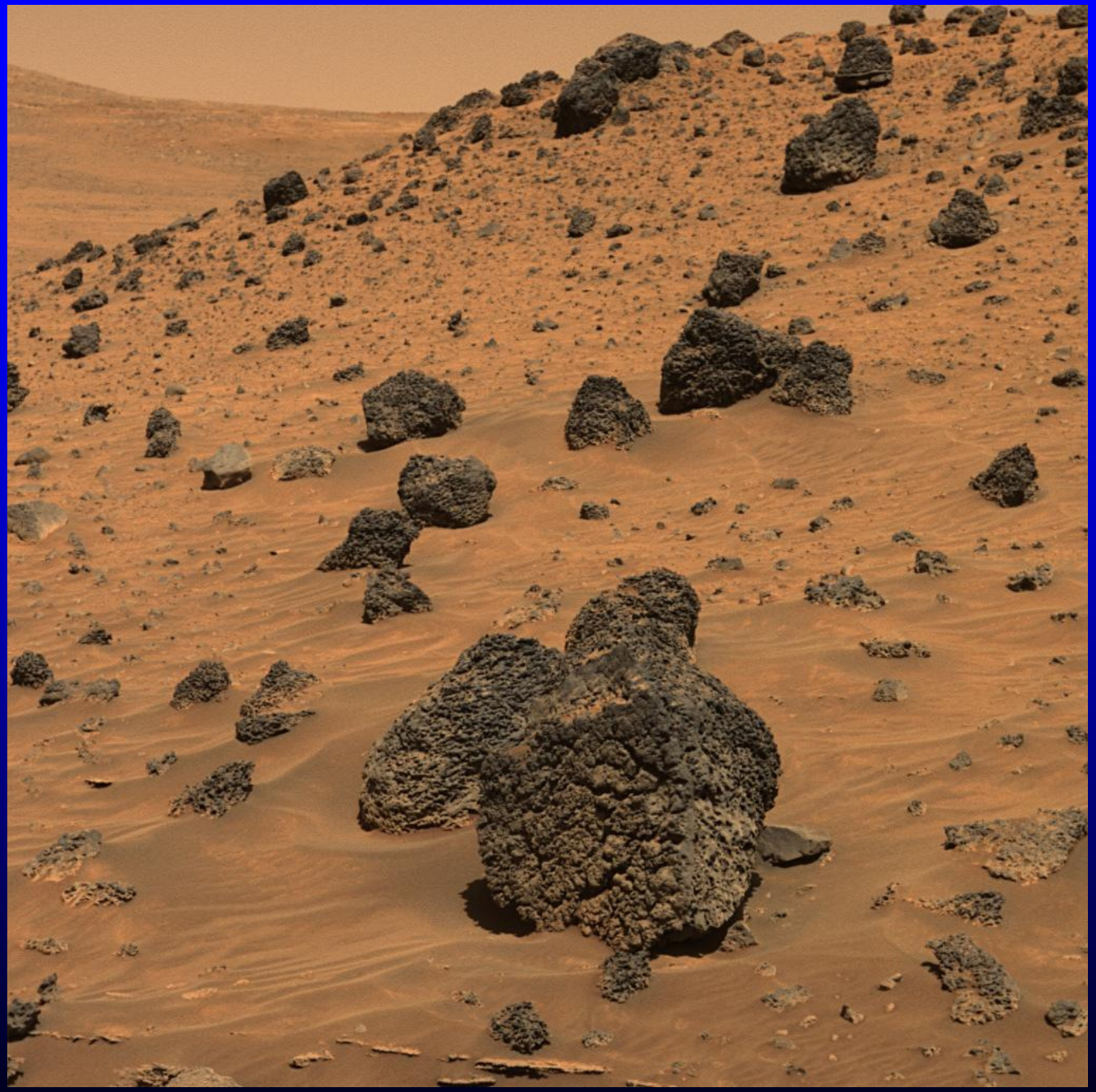




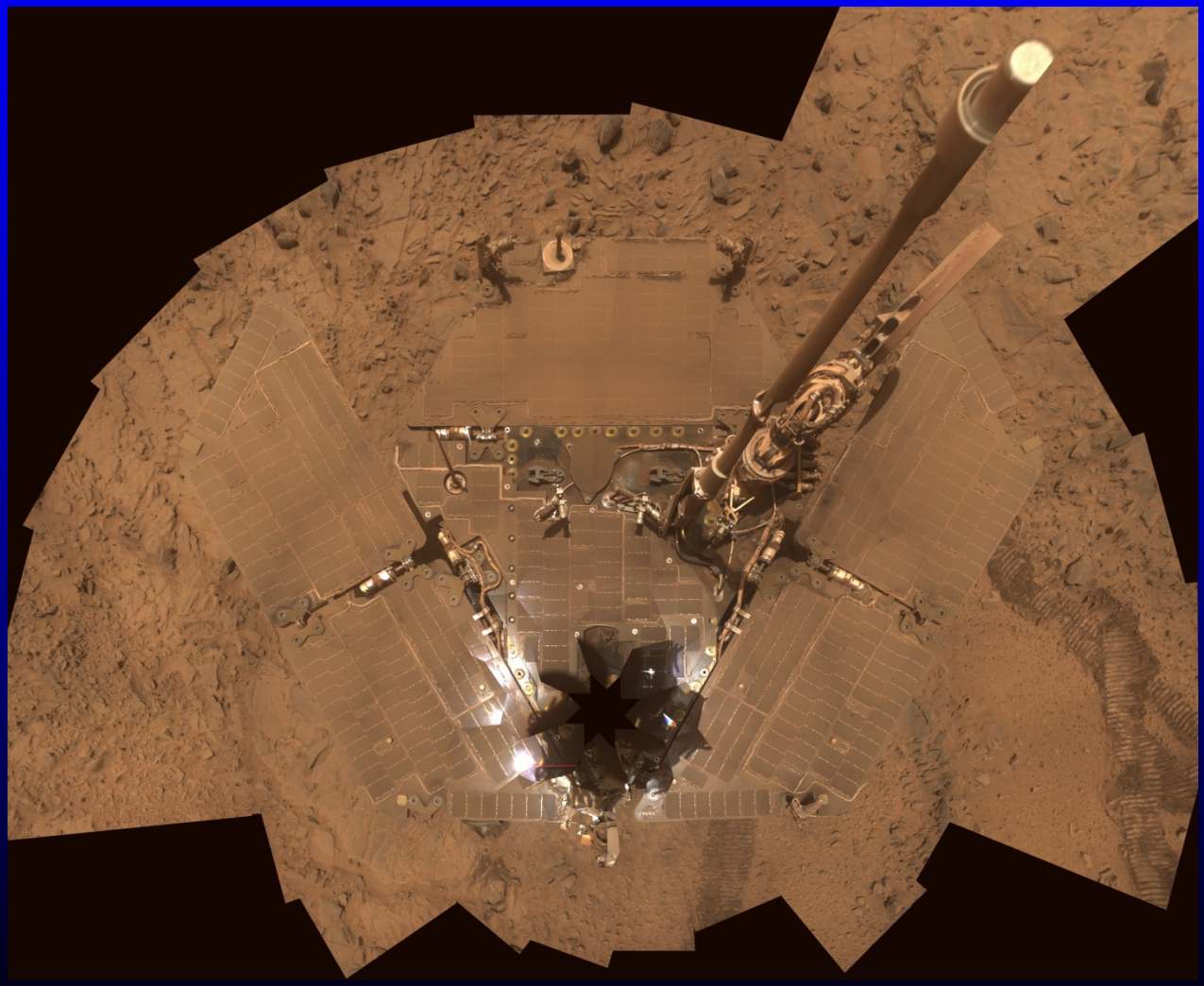

Backshell
Parachute
Heat Shield Impact
Bonneville
Crater
Track
Rover
Lander



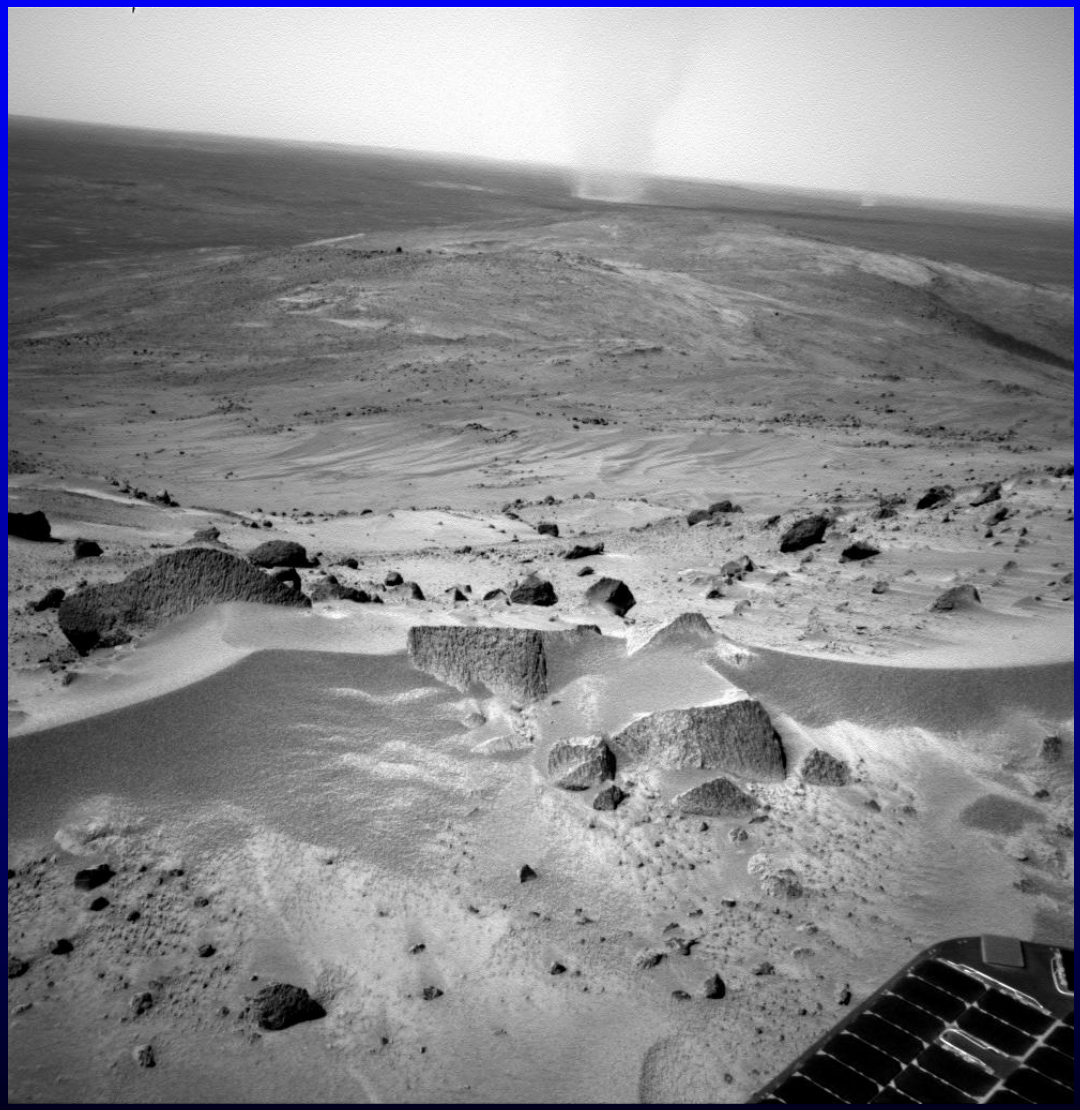

Bonneville Crater
Sol 66
Sol 1
Sol 108
Columbia
Memorial Station
Missoula Crater
Sol 117
Lahontan Crater
Sol 127
Sols 141
Sol 144
Sols 148 to 150
Sol 152
Columbia Hills
Sol 549
Sols 704
Sol 739
Sol 1506
Sol 1293
Home Plate
Sols 782 to 783
N
0
250
500
1000
Meters
OSU Mapping and GIS Laboratory
Image sources: NASA/JPL/Cornell/MSSS



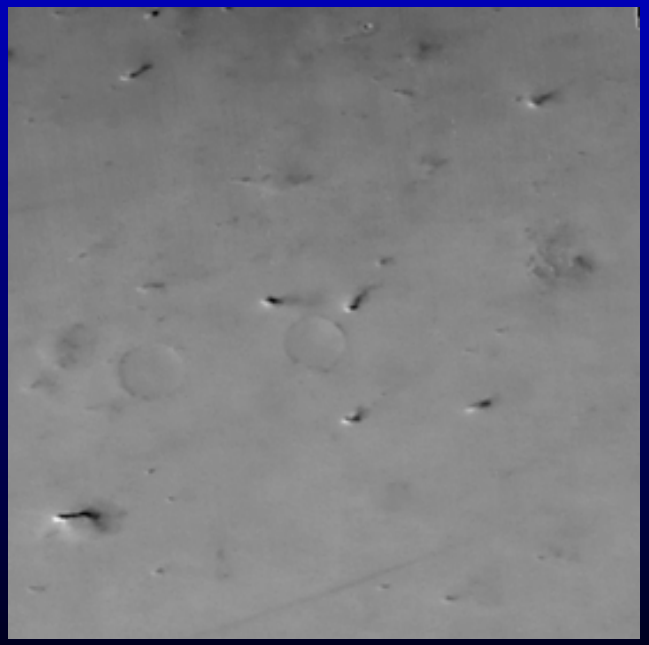
Dust Covered Solar Panels

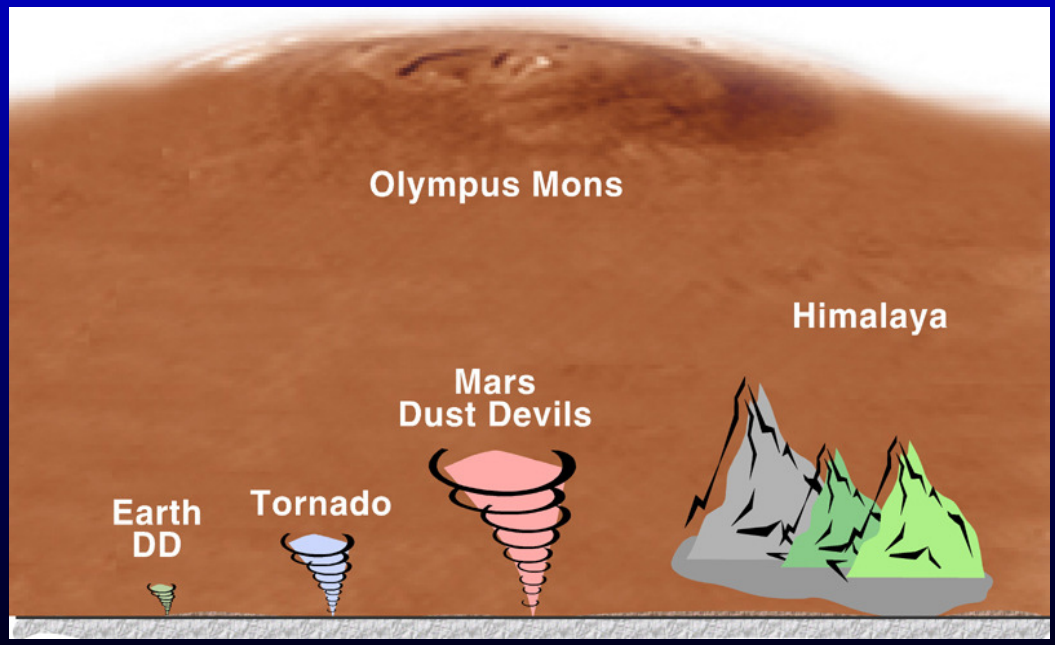


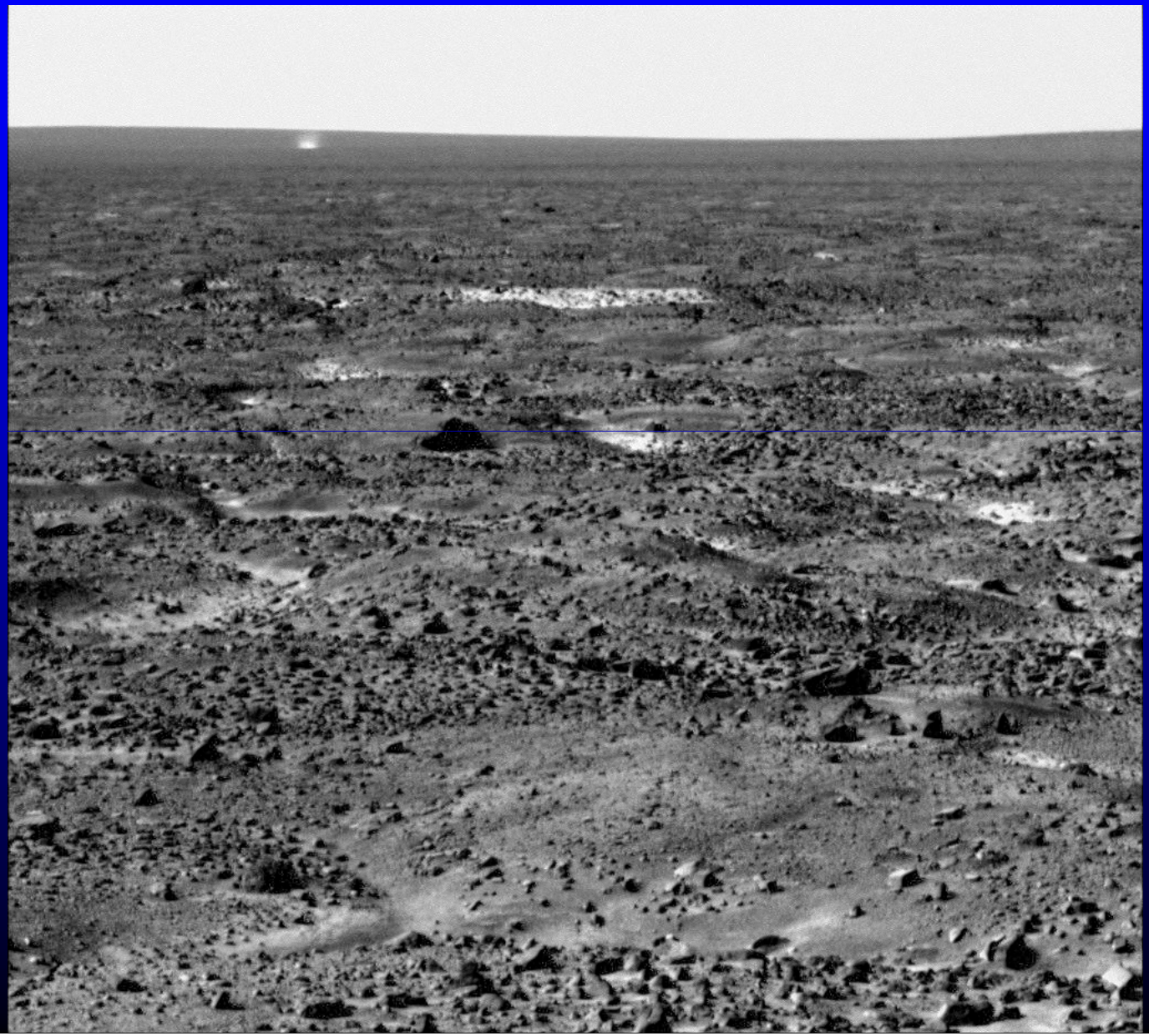
A Dust Devil



Dust Devils



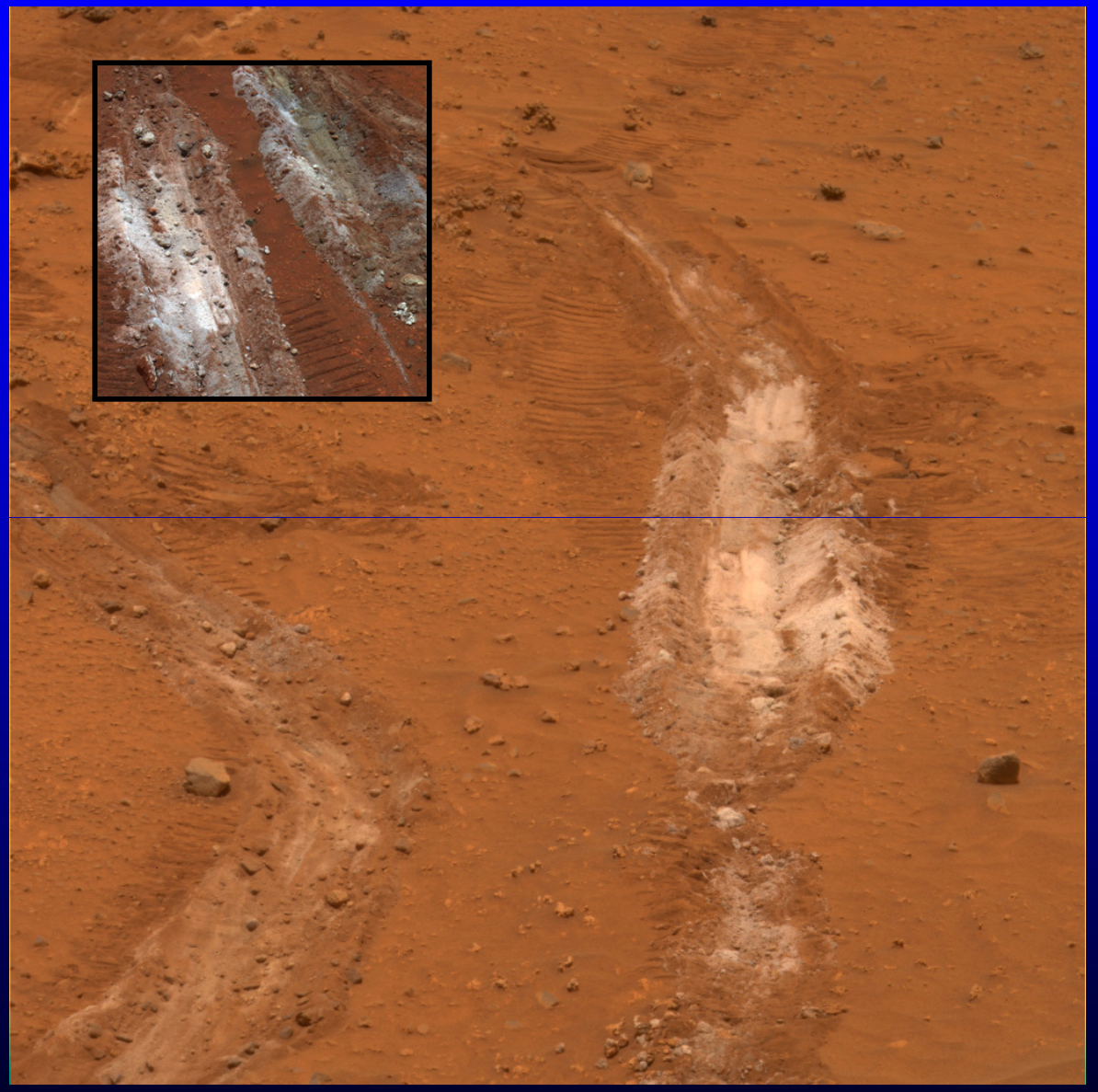




A Dragging Wheel

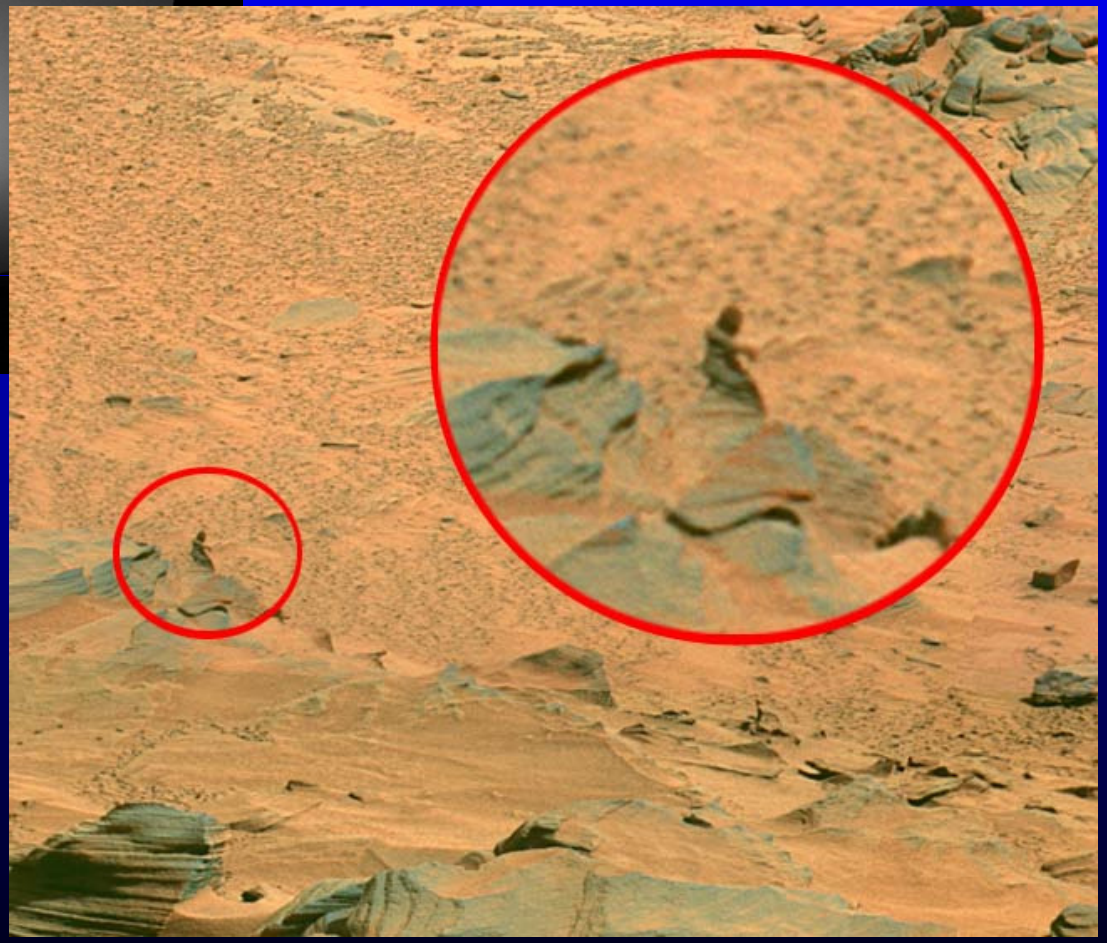
Silica-rich Soil

- 90% Silicon Dioxide.
- Produced by hydrothermal vents.
- 1200 days in!

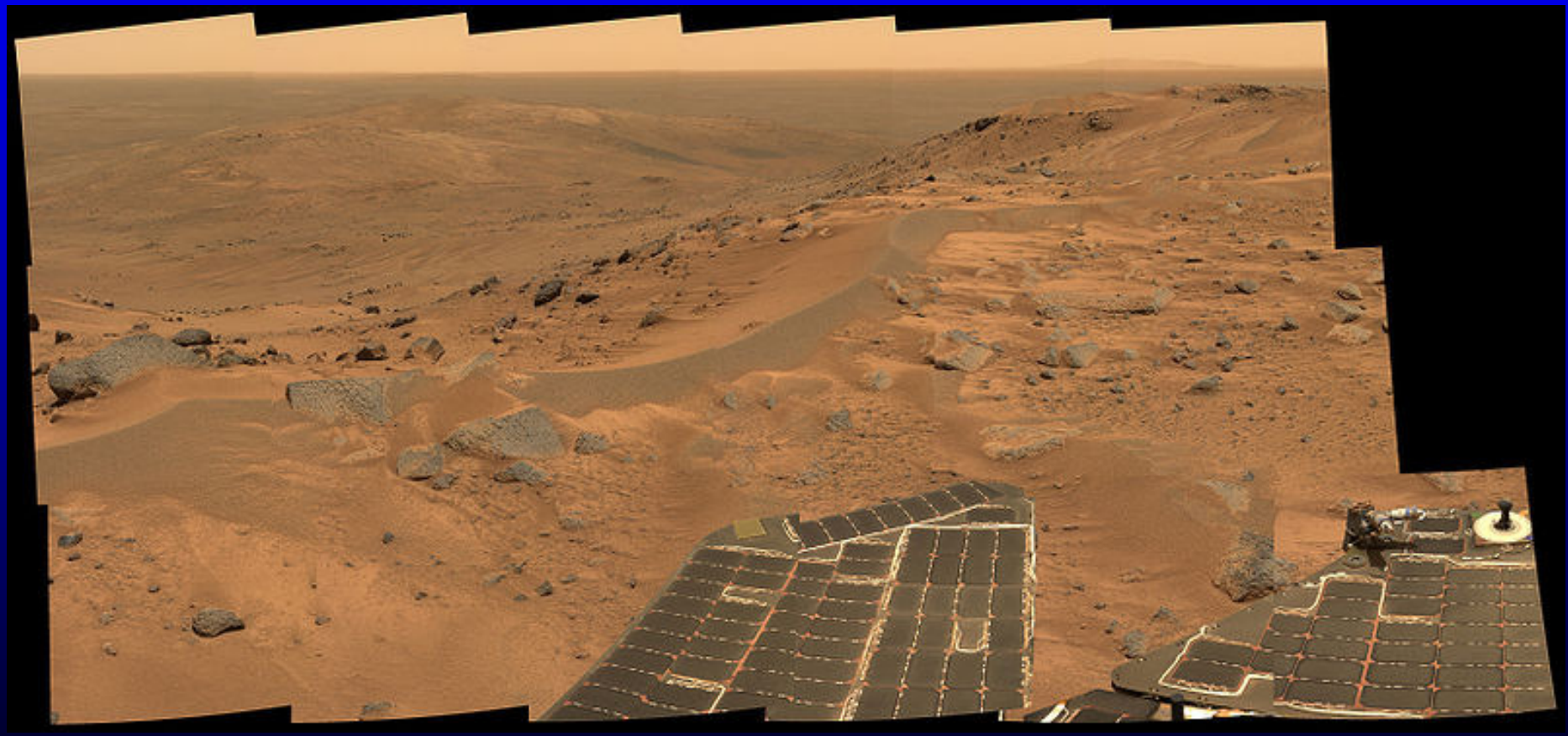


Yellowstone Park

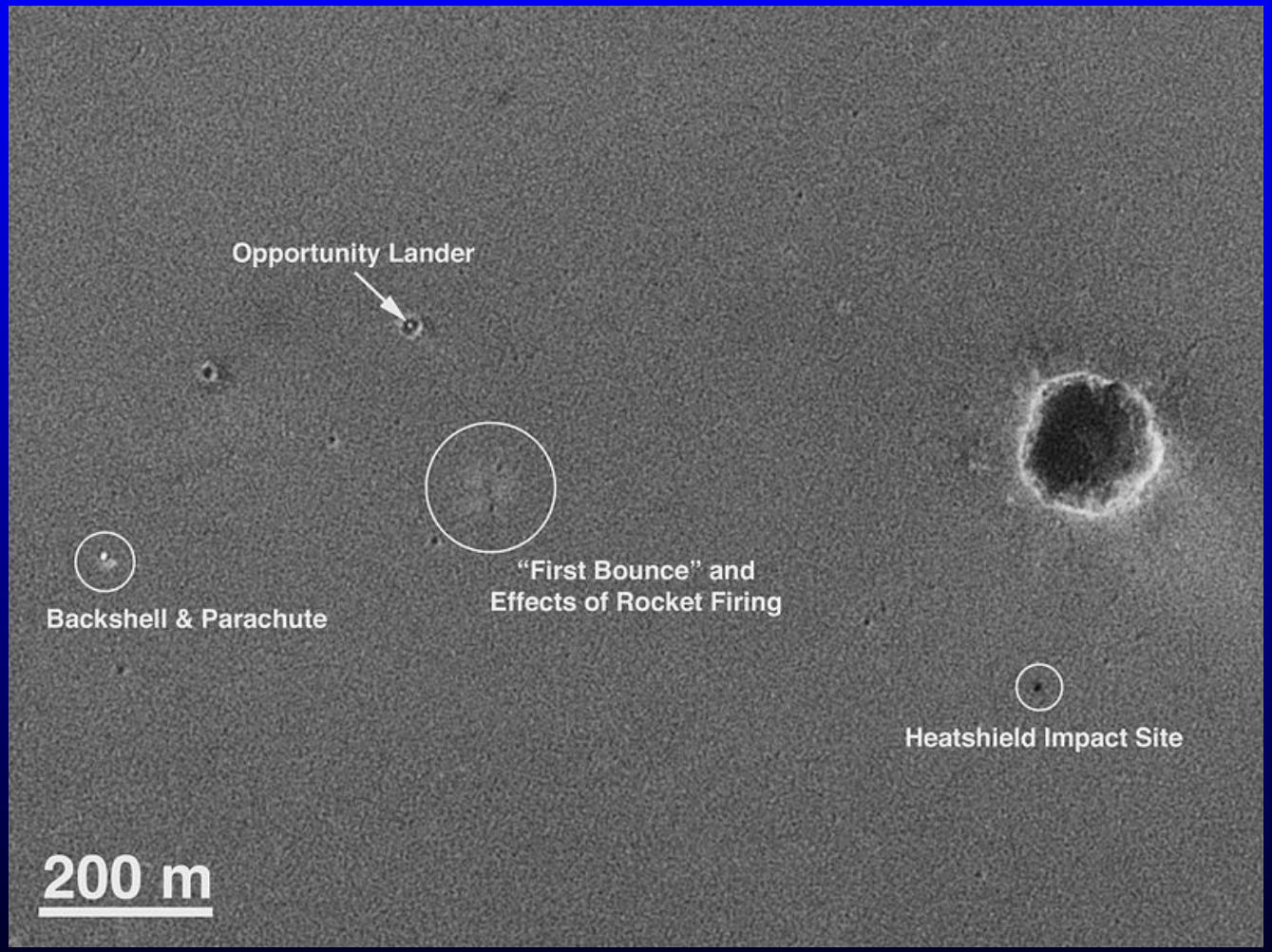
The Earth and a Martian



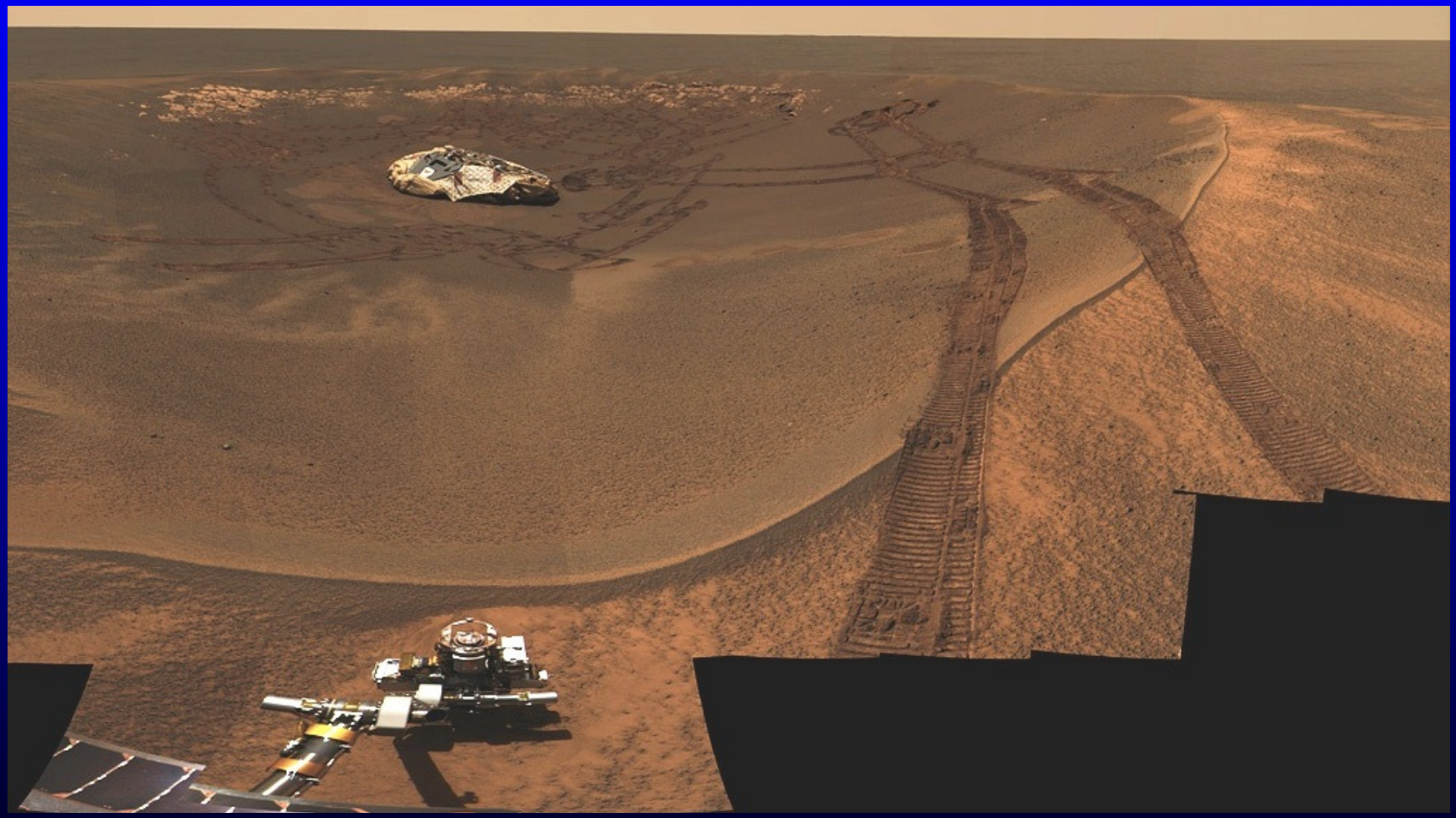
Postcard from Husband Hill



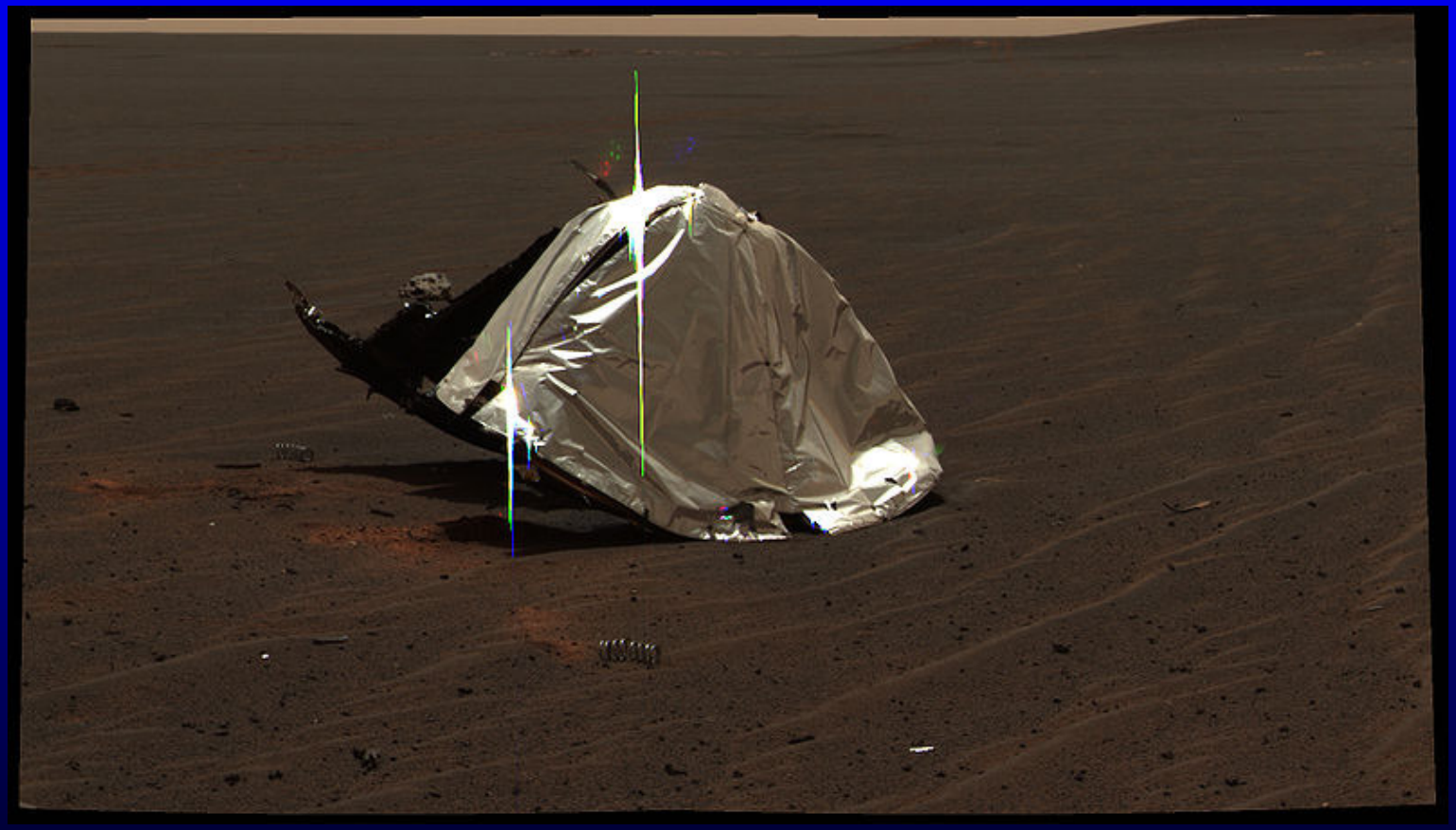
Opportunity



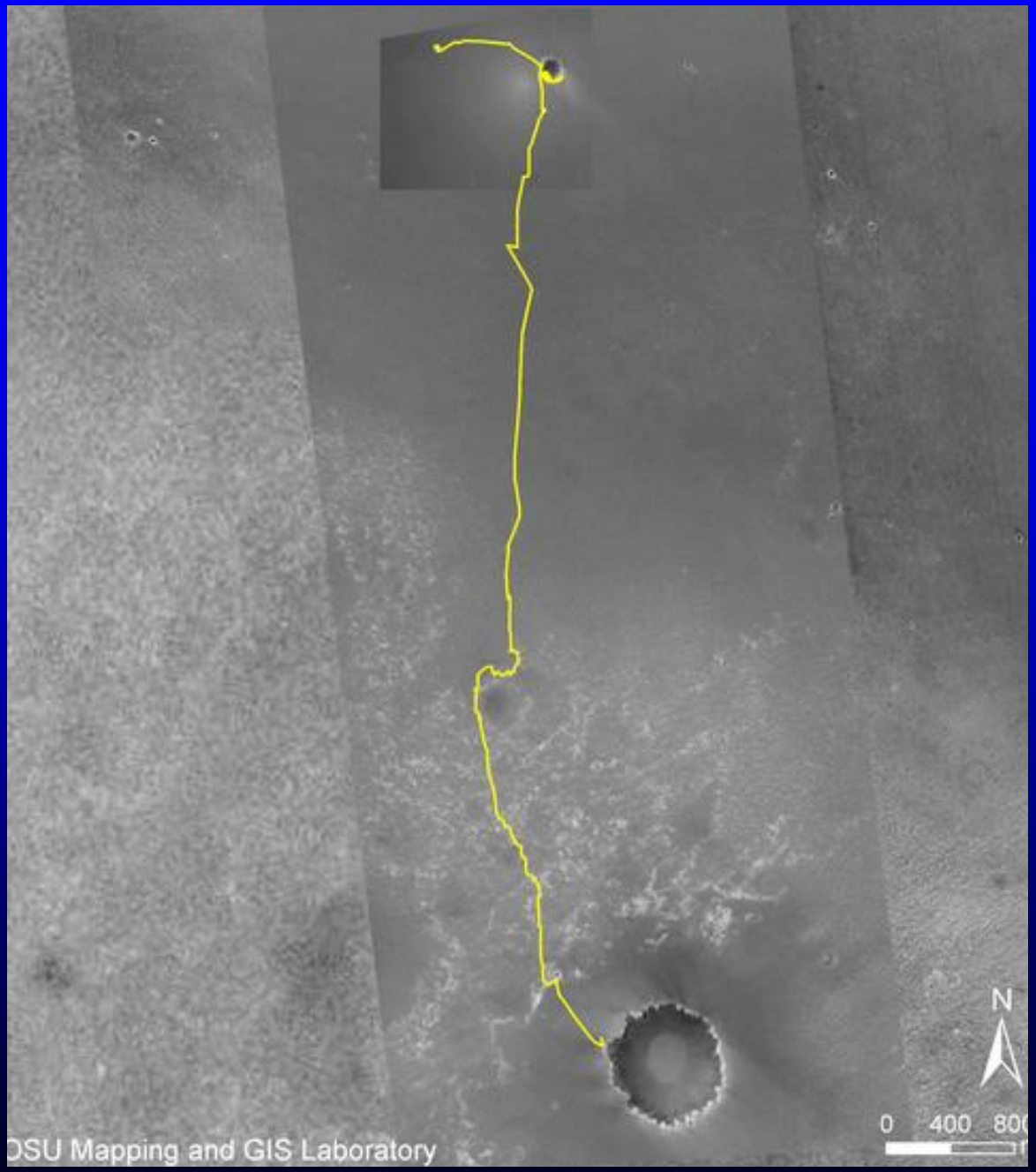
Climbing Out!



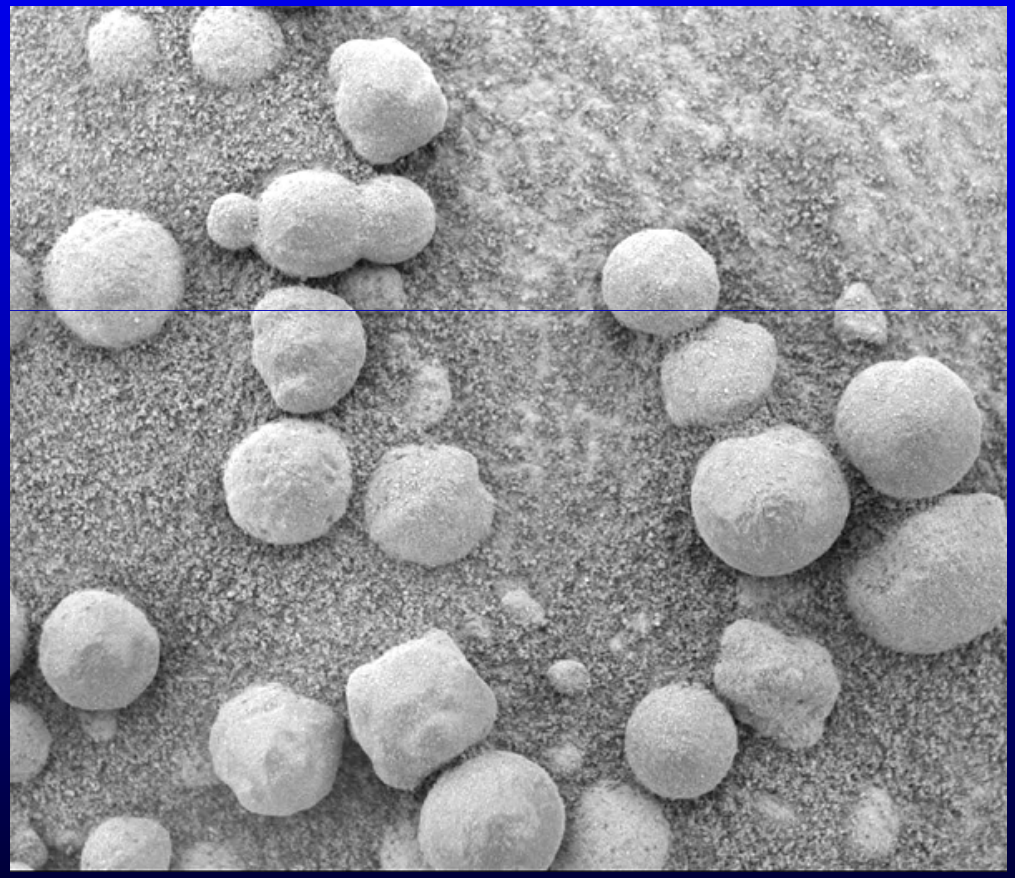
Nose Cone and Rock



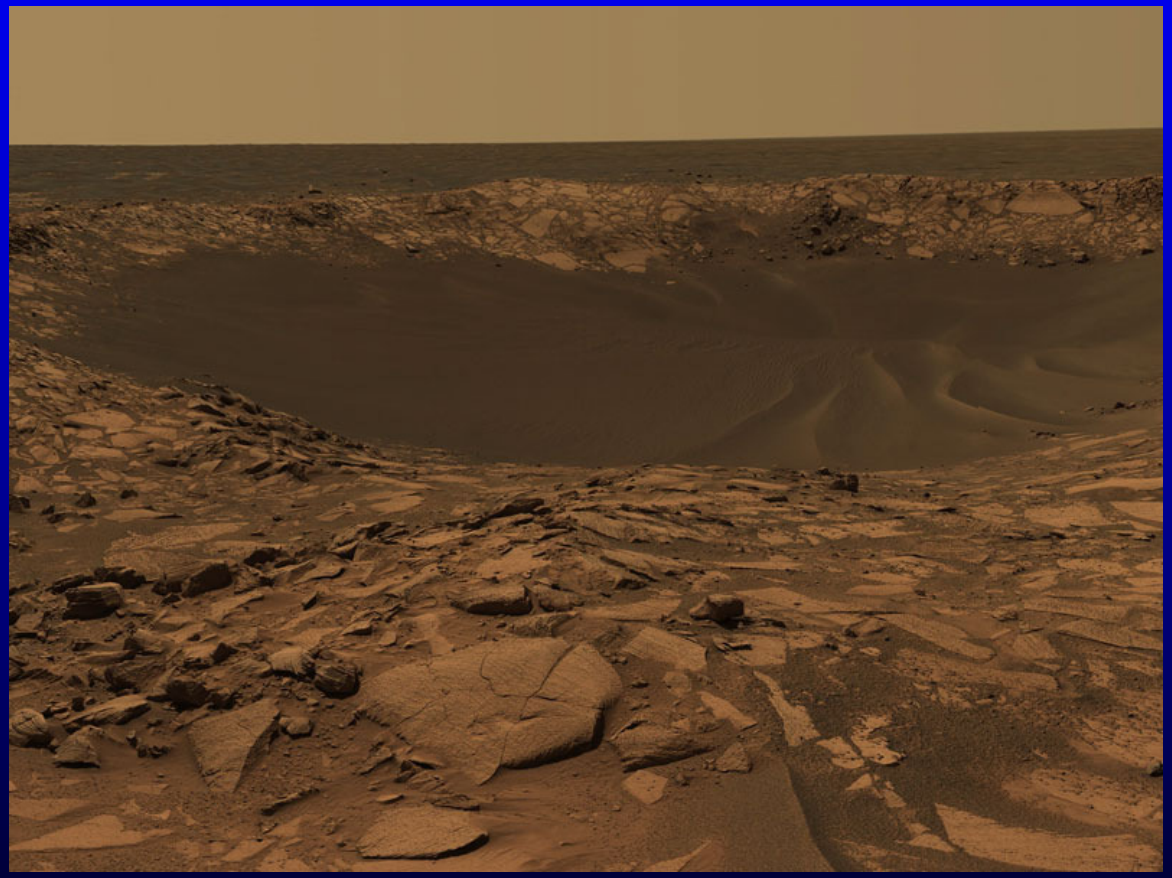
A Meteorite – Heat Shield Rock!


N
0 400 800
OSU Mapping and GIS Laboratory

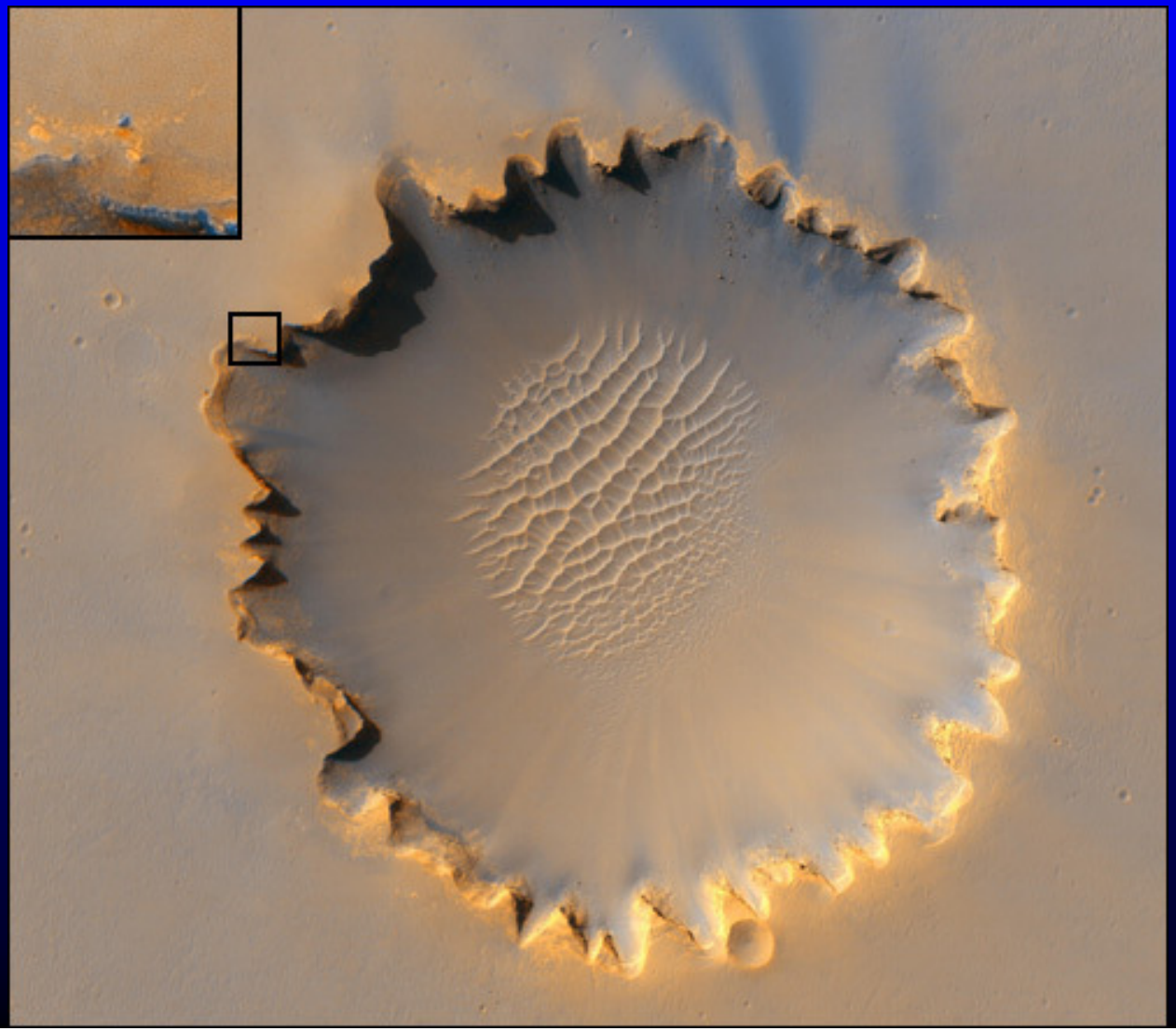
“Blueberries”



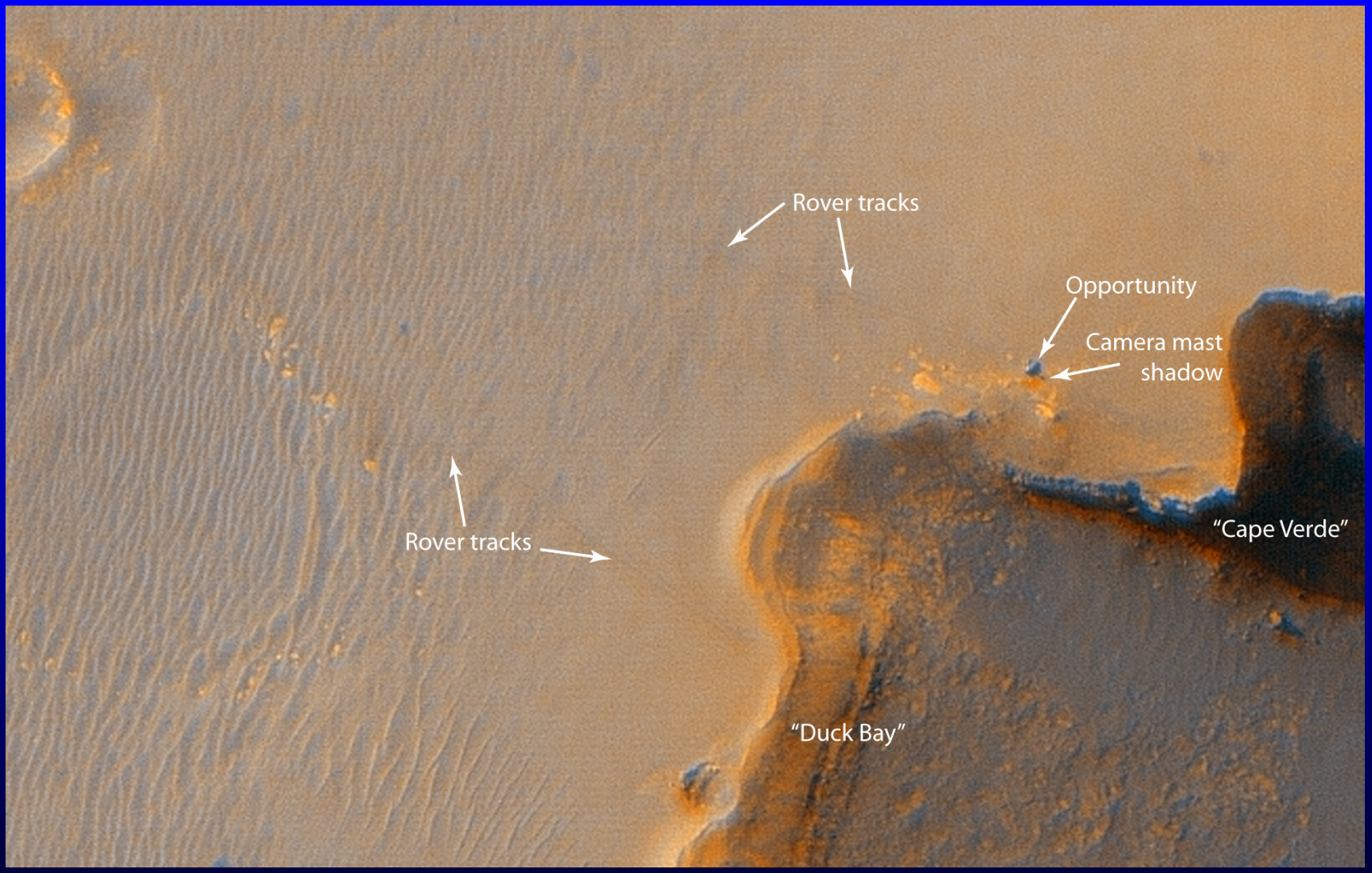
Beagle Crater

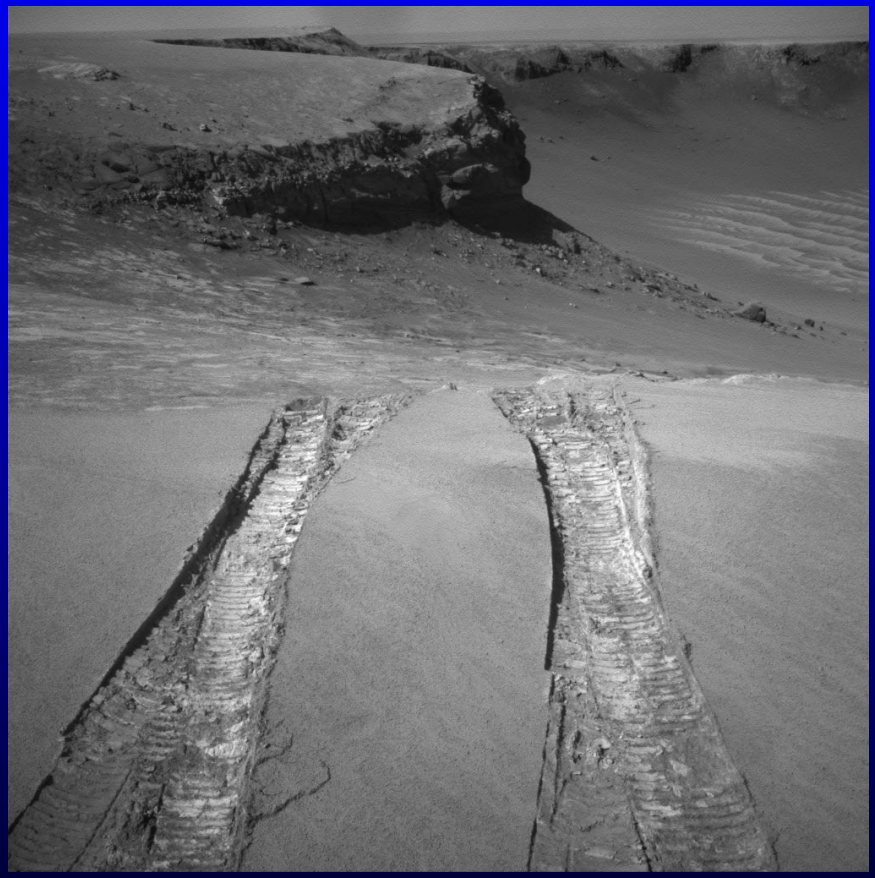


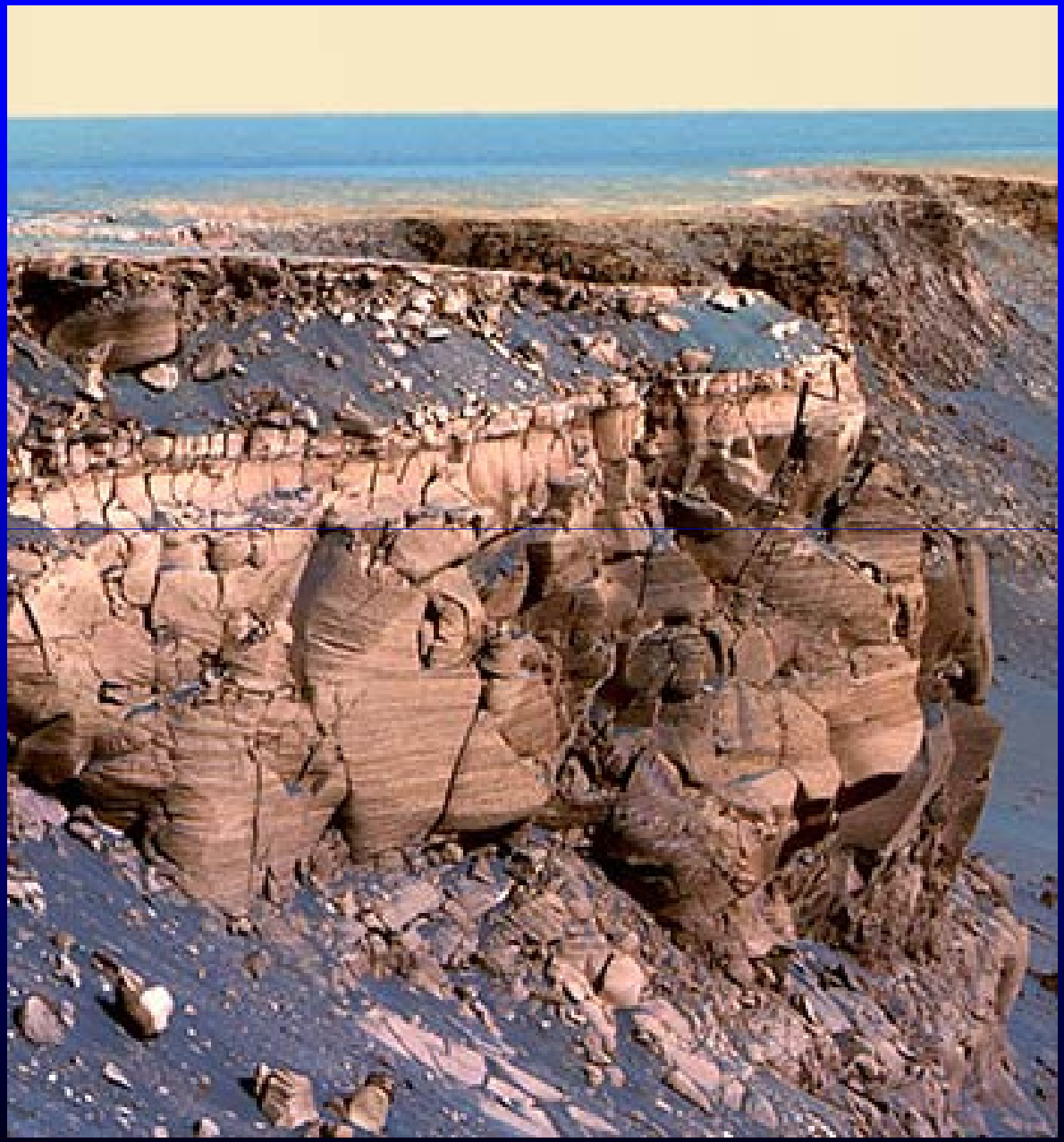
Victoria Crater

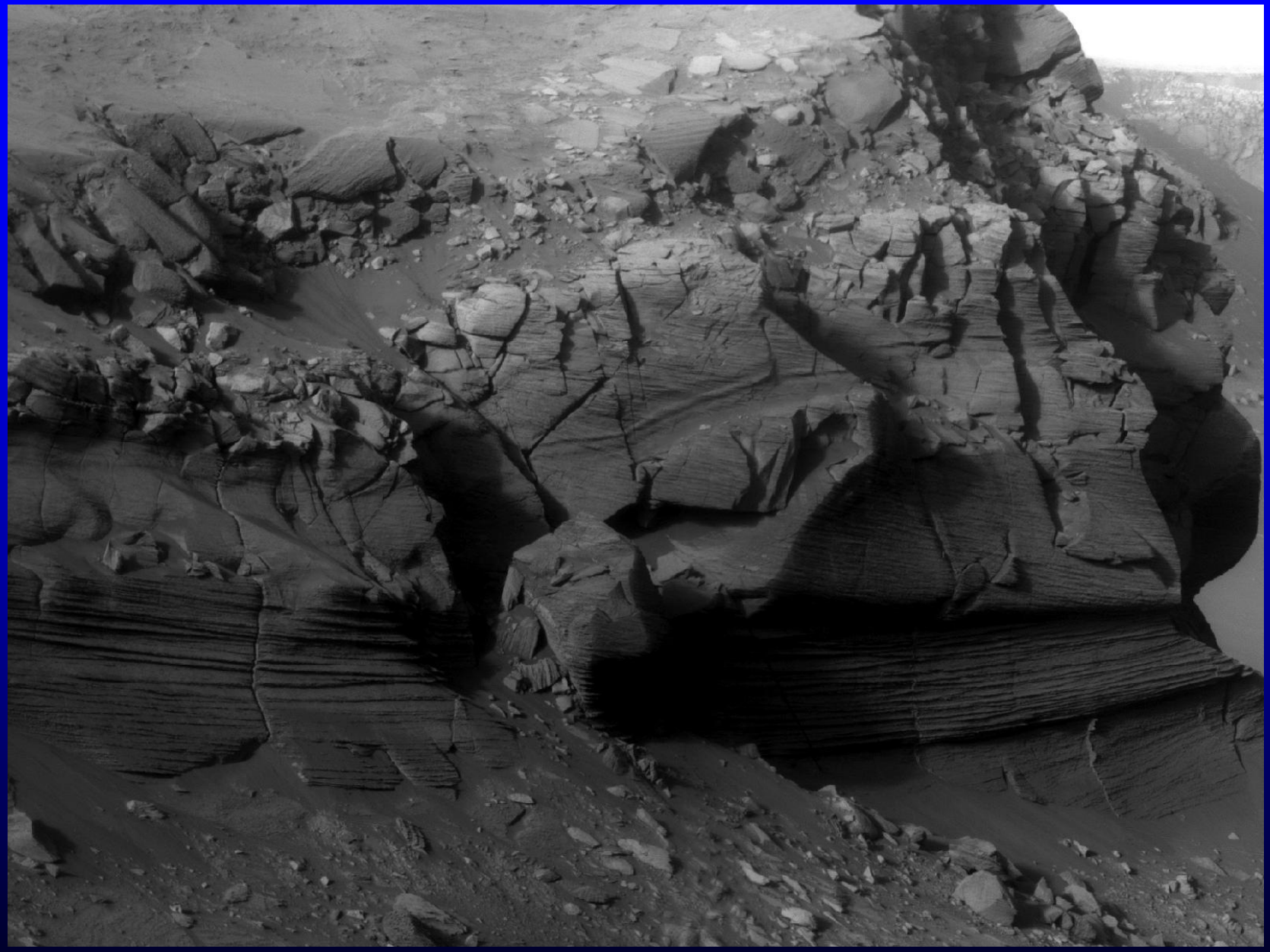


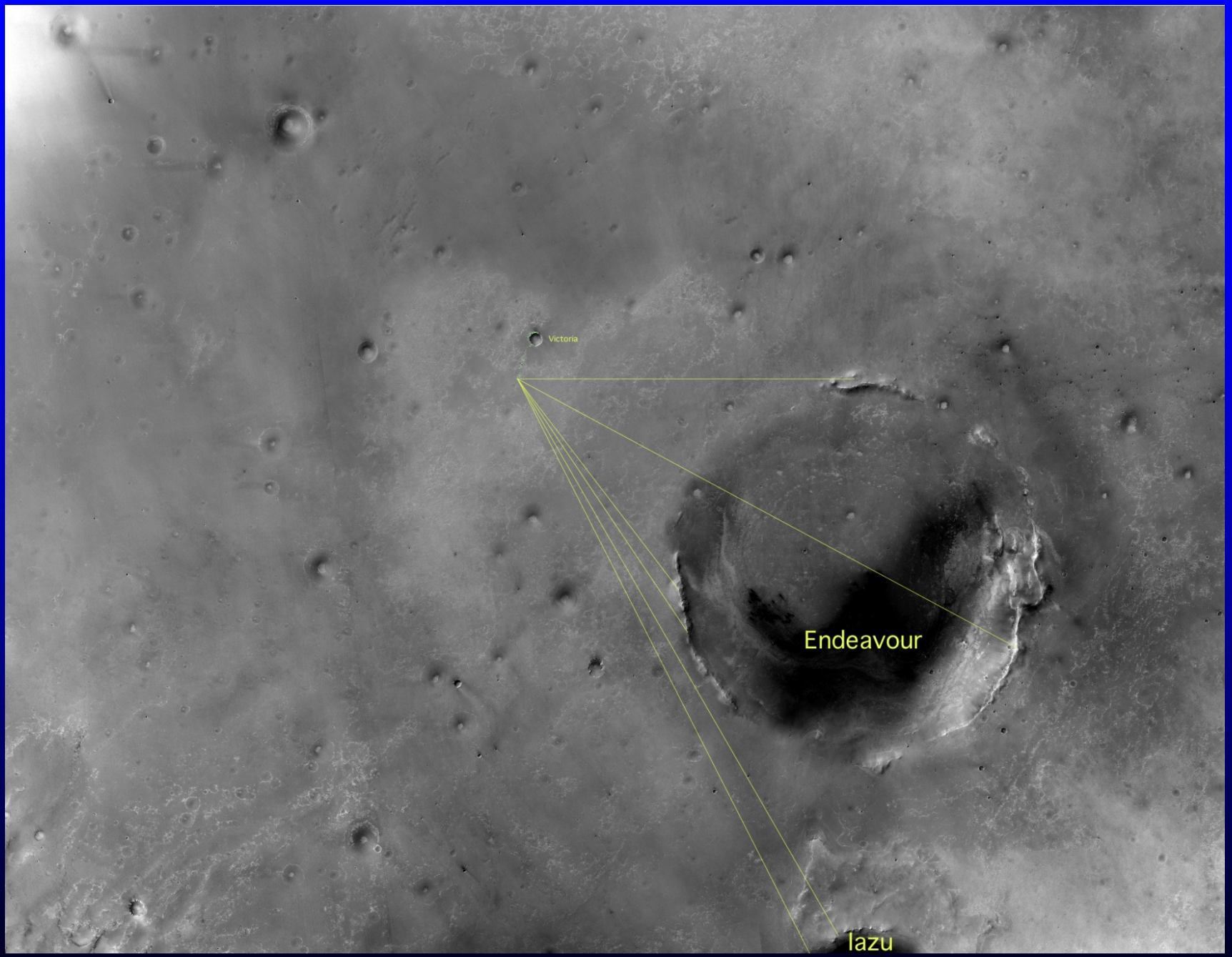
Victoria Crater


Rover tracks
Opportunity
Camera mast shadow
Rover tracks
"Cape Verde"
"Duck Bay"





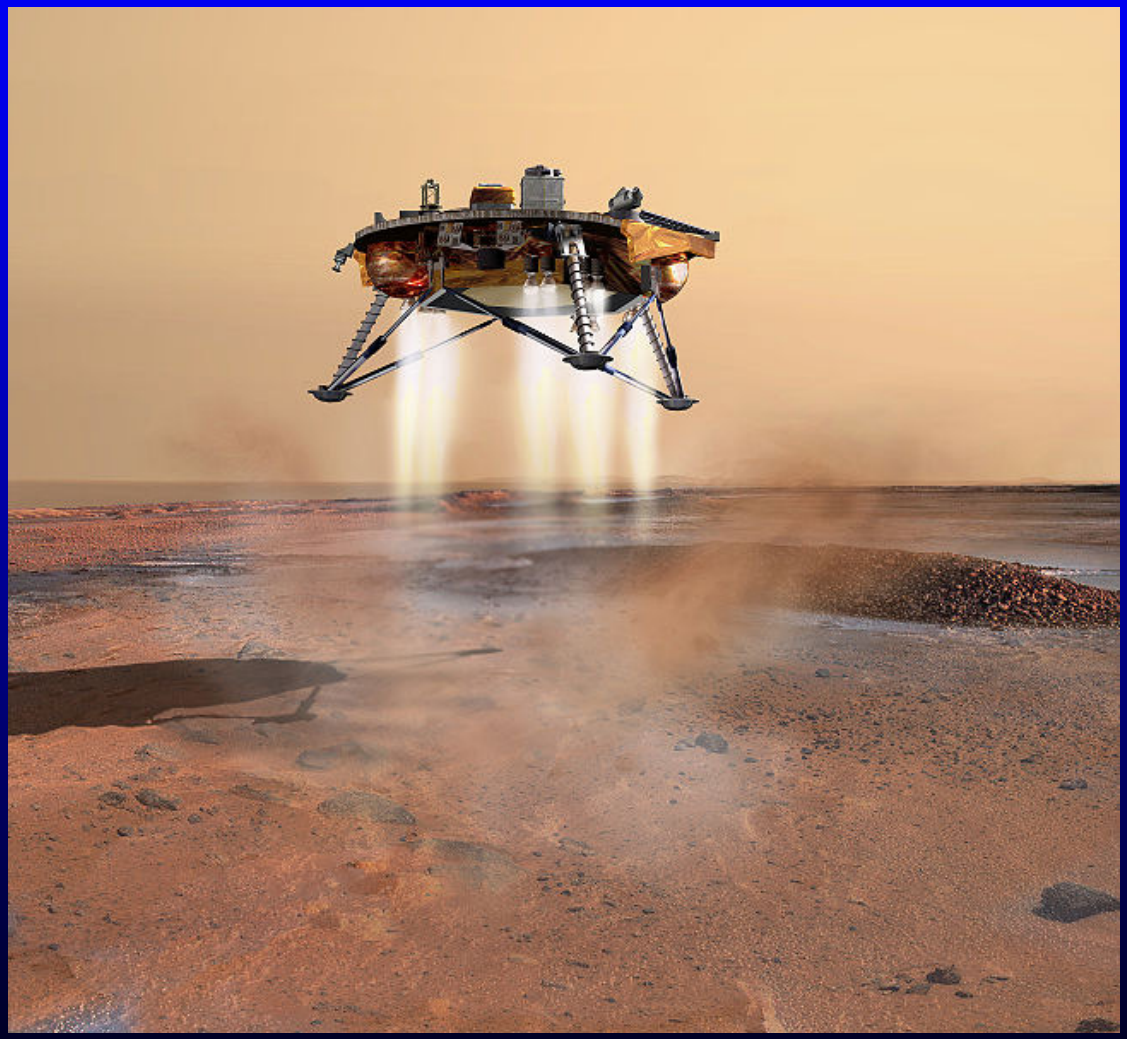


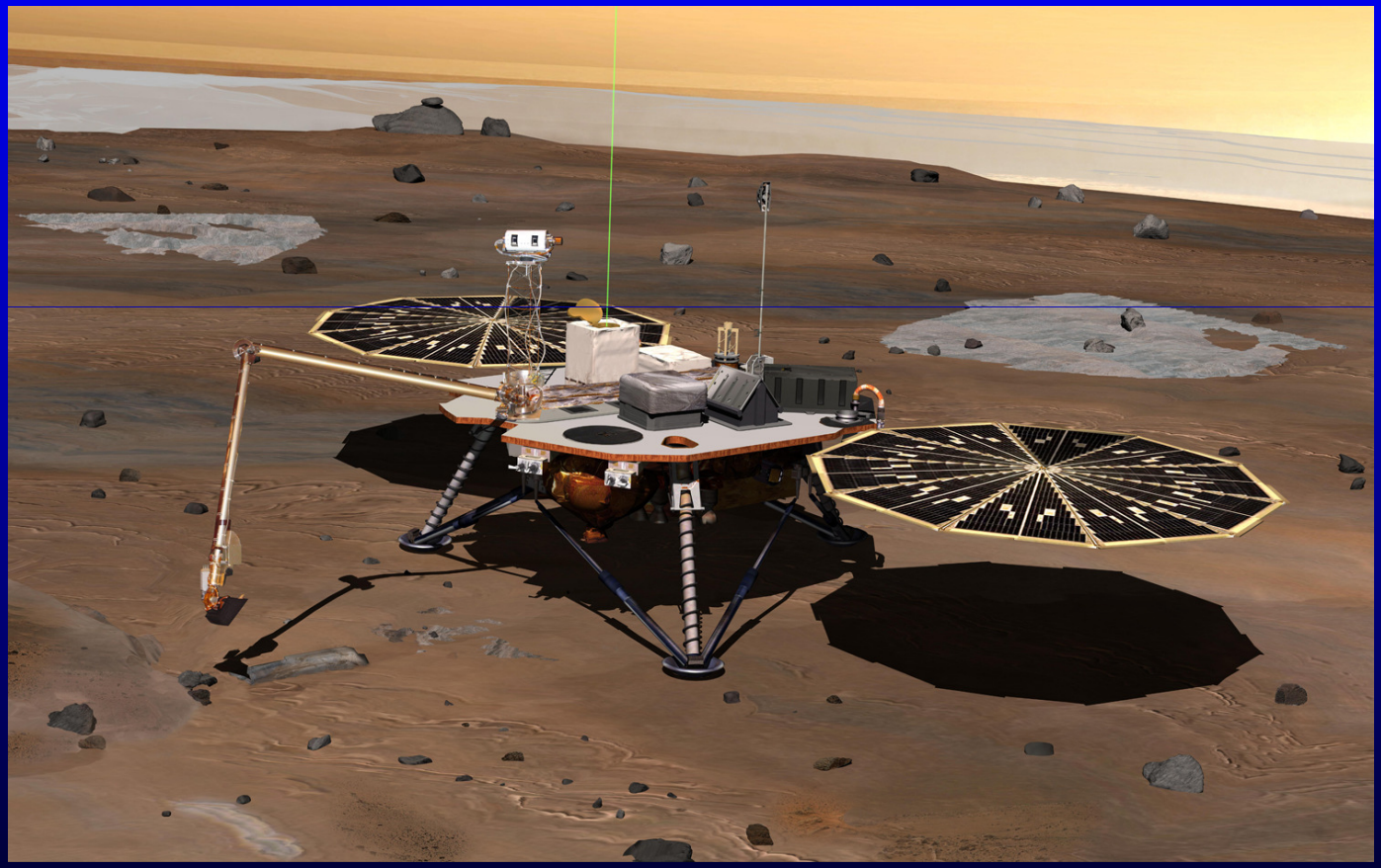

Victoria
Endeavour
Iazu

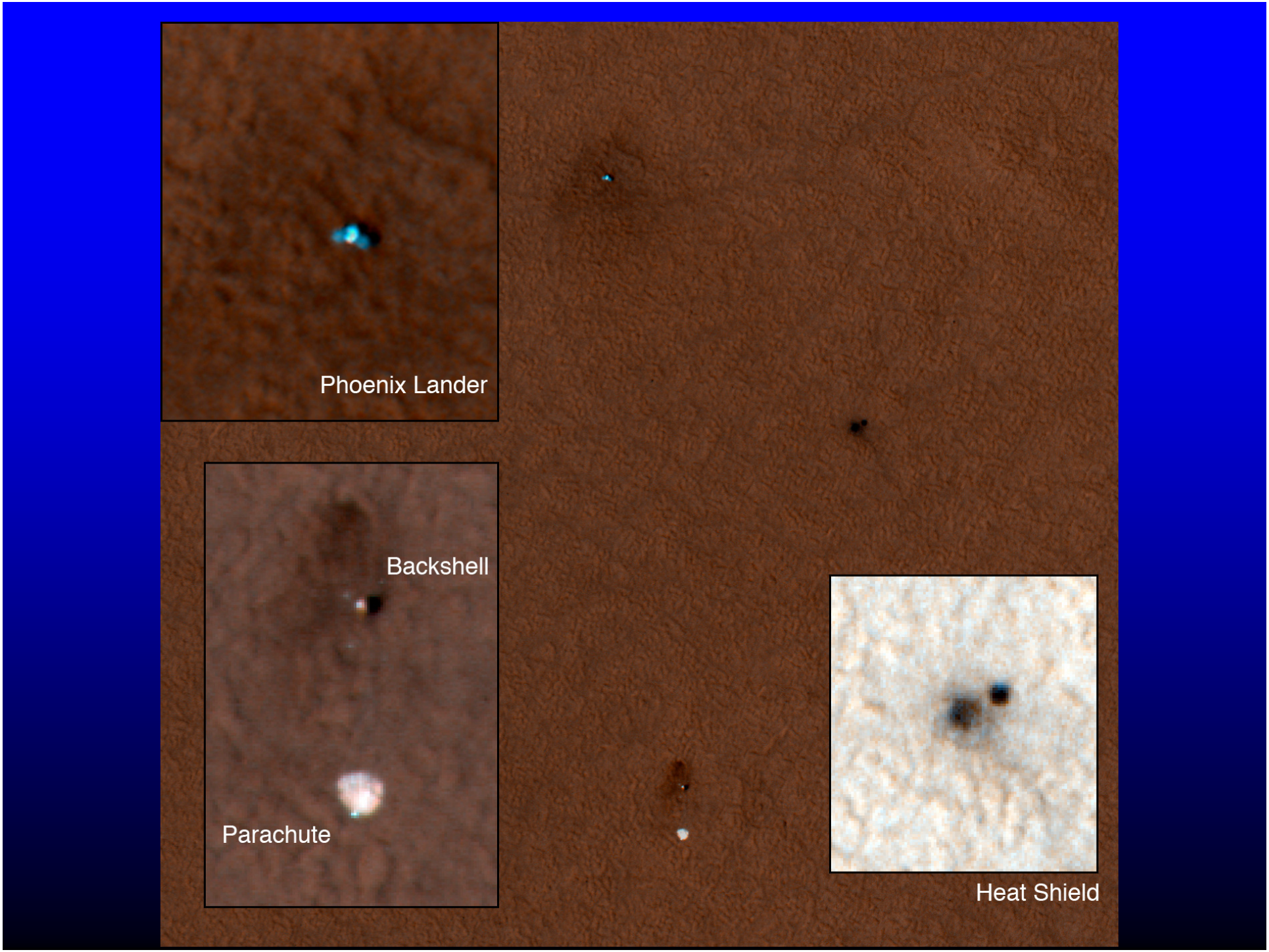
The Phoenix Lander

Descent!

Landing

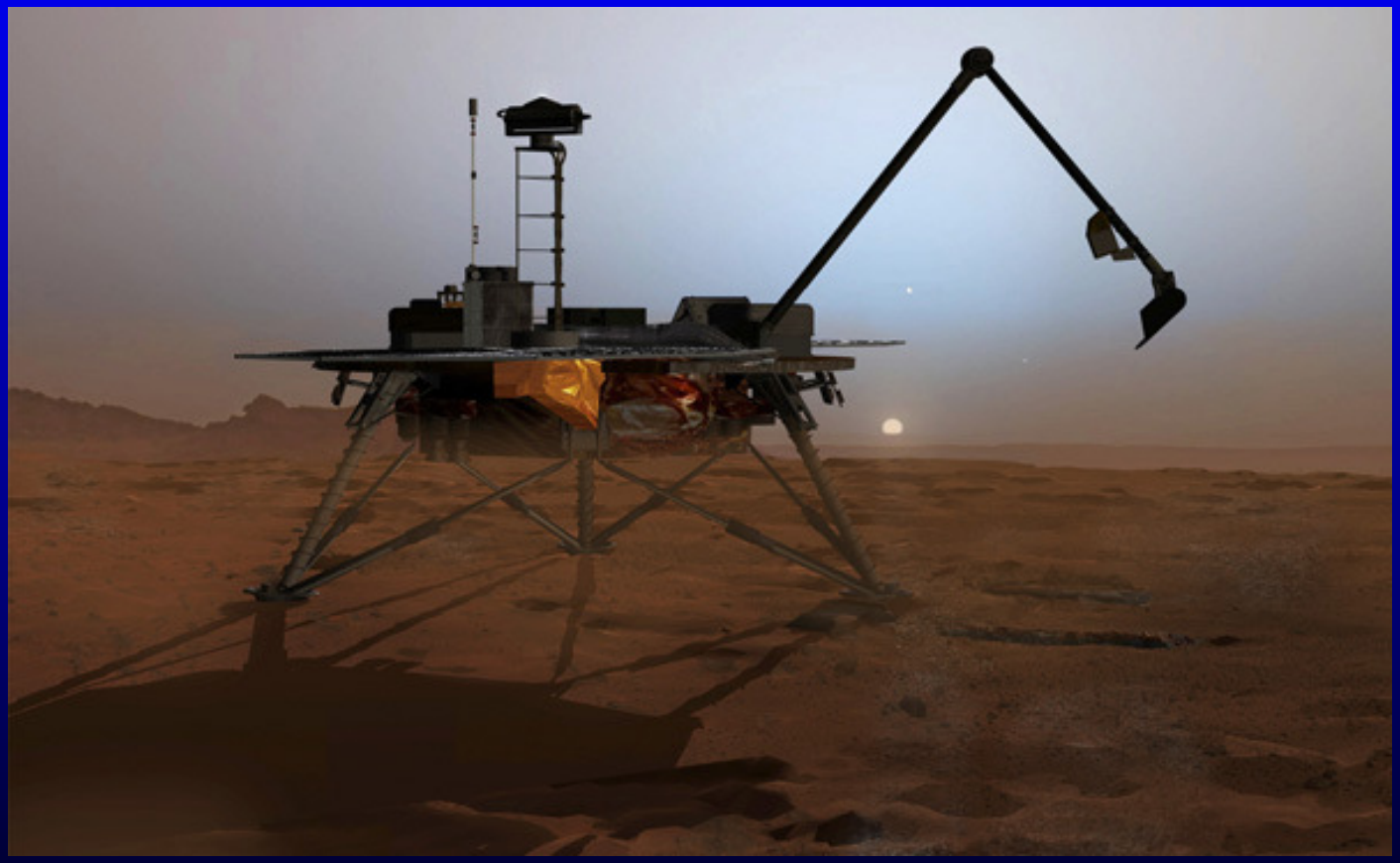




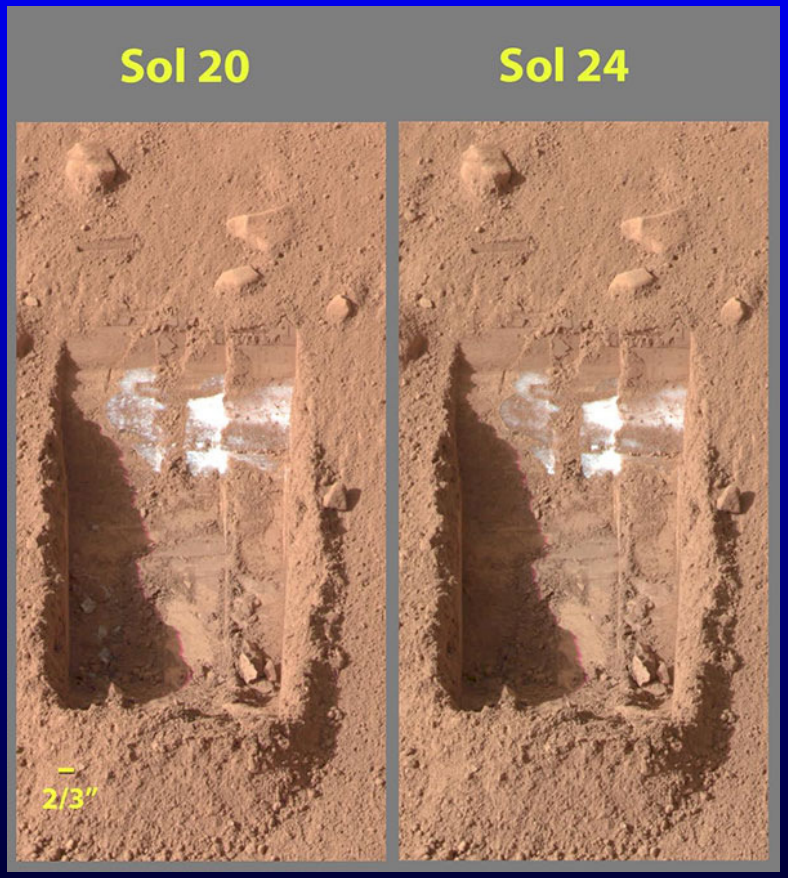

Phoenix Lander
Backshell
Parachute
Heat Shield

Ice below Phoenix?

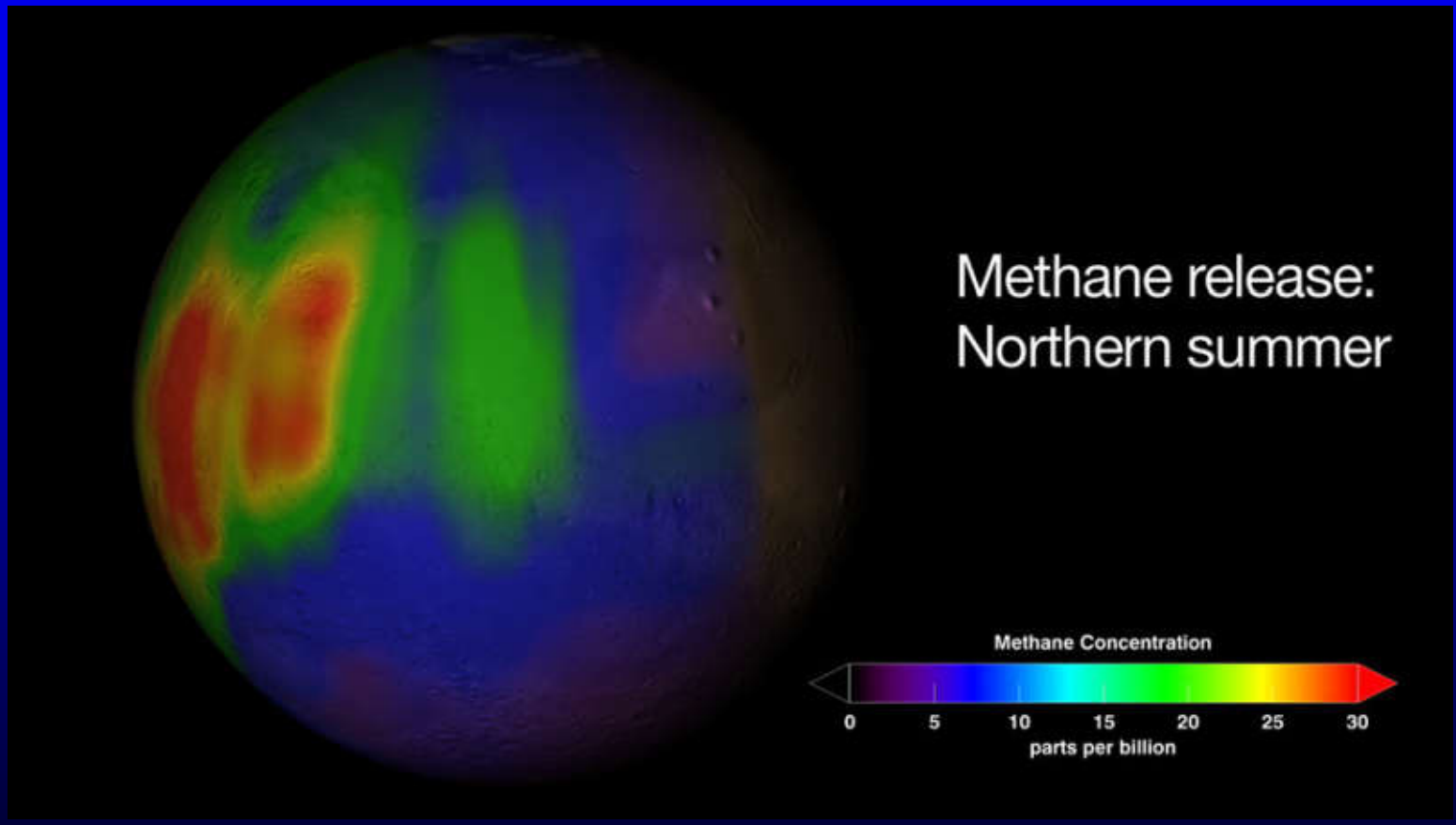
The Scoop



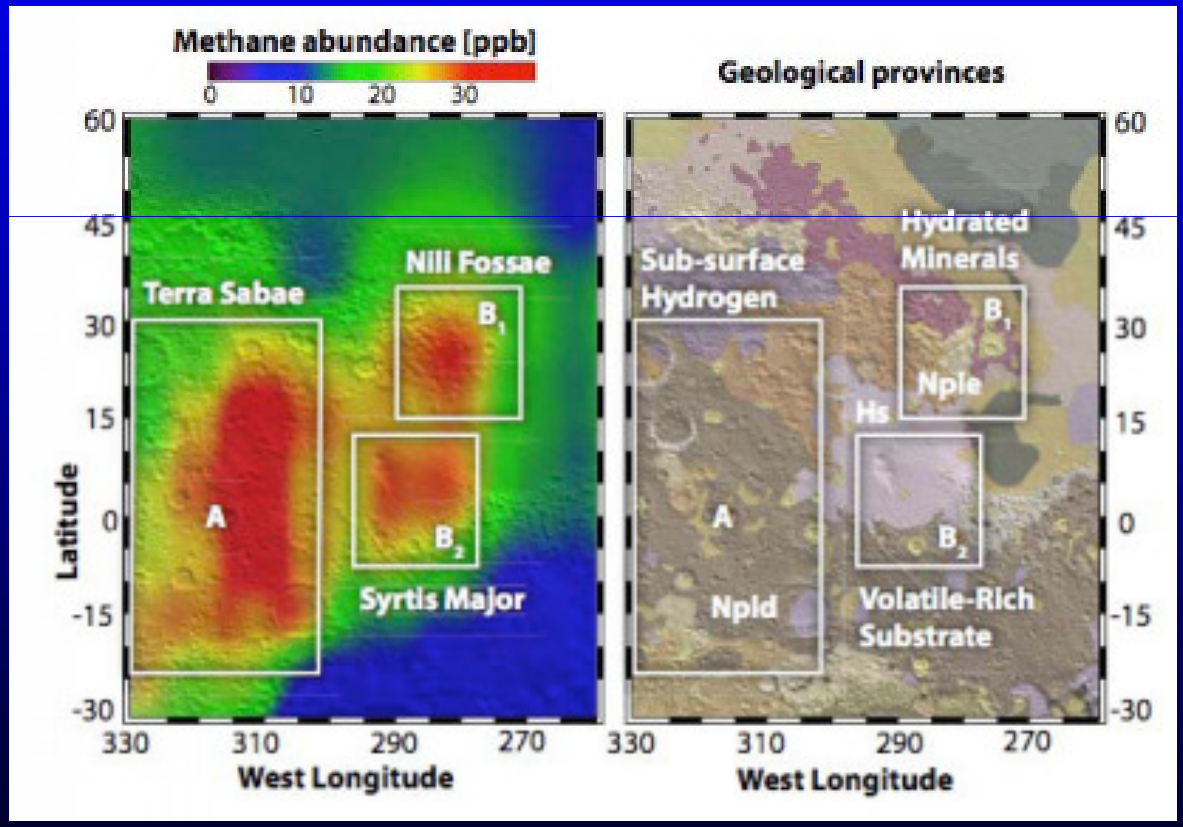
Permafrost!



Methane in the Atmosphere


Methane release:
Northern summer
Methane Concentration
0
5
10
15
20
25
30
parts per billion

Mars must produce 270 tons per annum.



What Cause?

Biological origin, present or past?

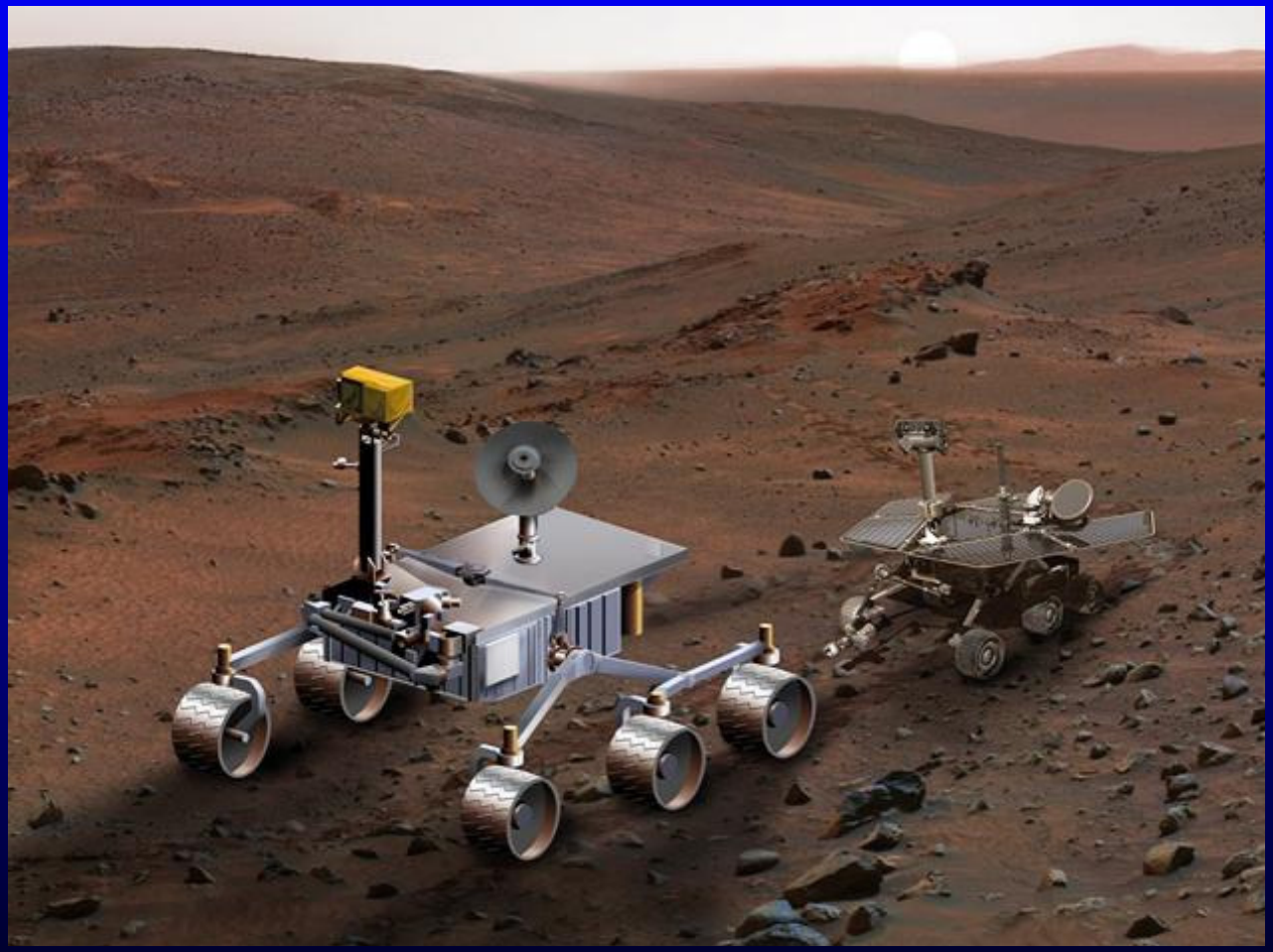
Lack of volcanic activity, hydrothermal activity or hotspots does not suggest geologic origins.

It was recently shown that methane could be produced by a non-biological process involving water, carbon dioxide, and the mineral olivine, which is known to be common on Mars.

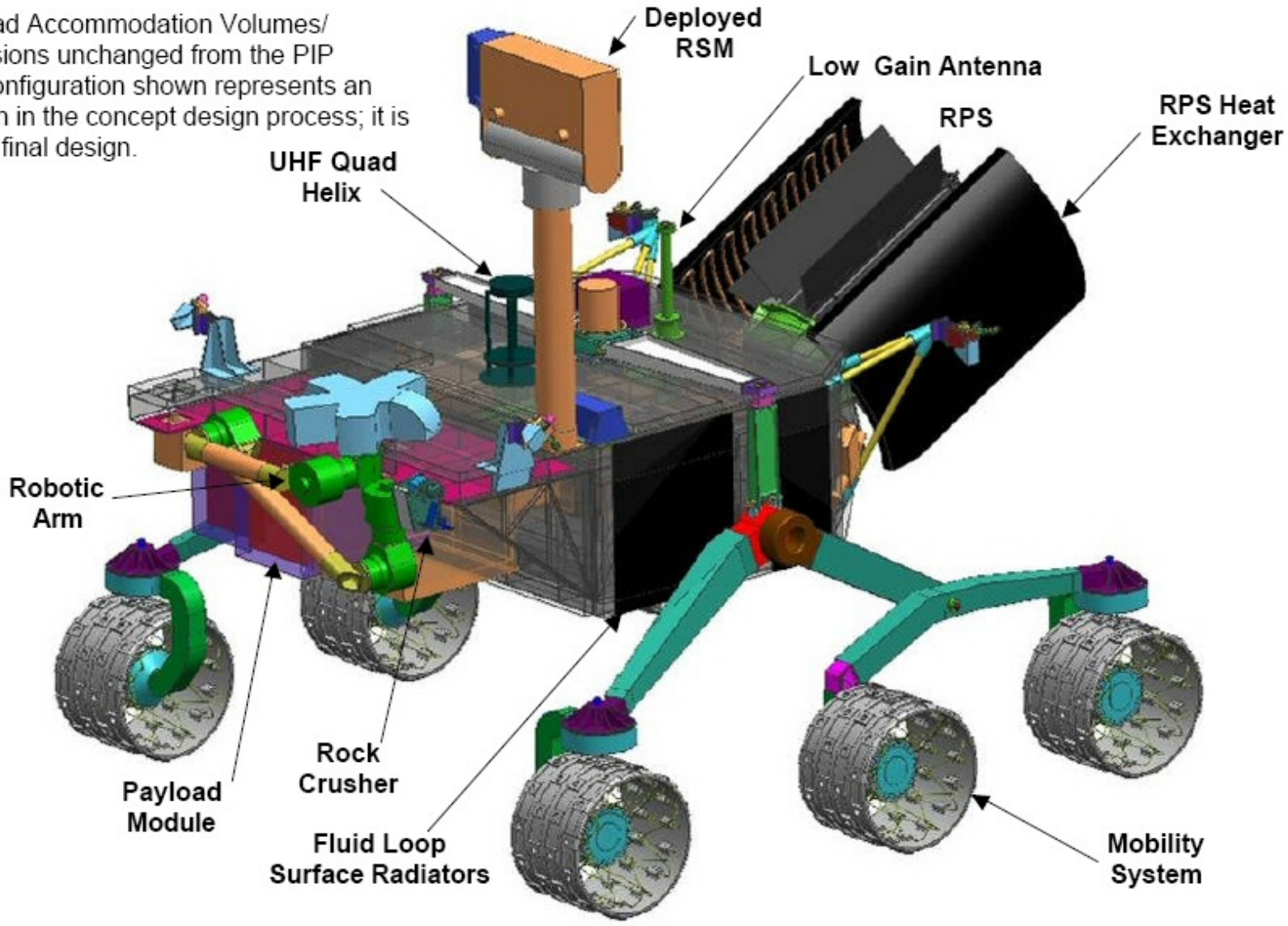
Mars Science Laboratory

Named “Curiosity”

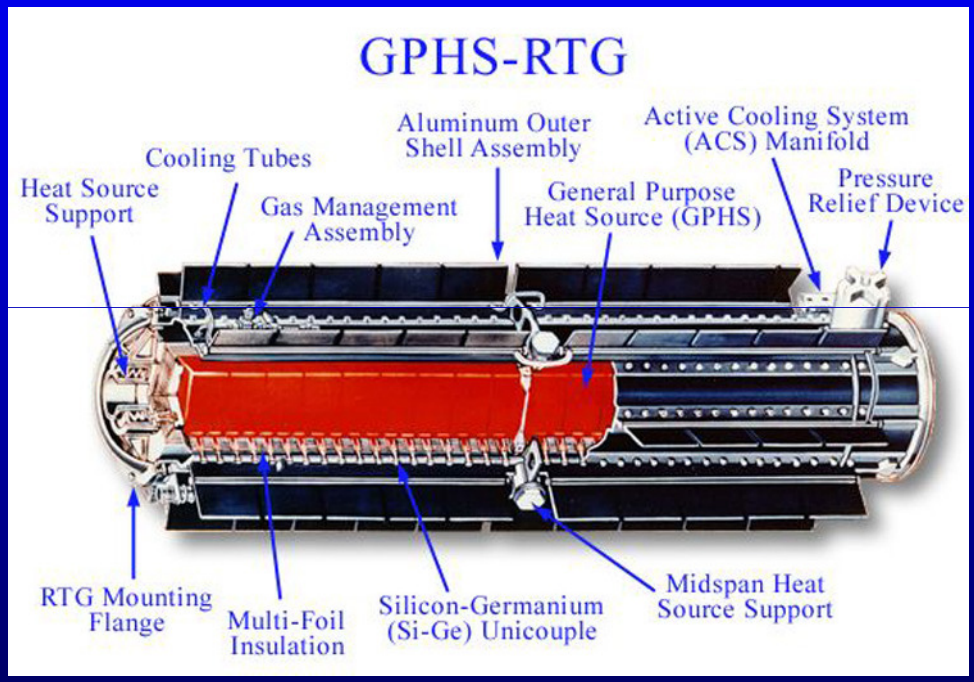
Compared to Spirit



- Payload Accommodation Volumes/ Dimensions unchanged from the PIP
- The configuration shown represents an iteration in the concept design process; it is not the final design.

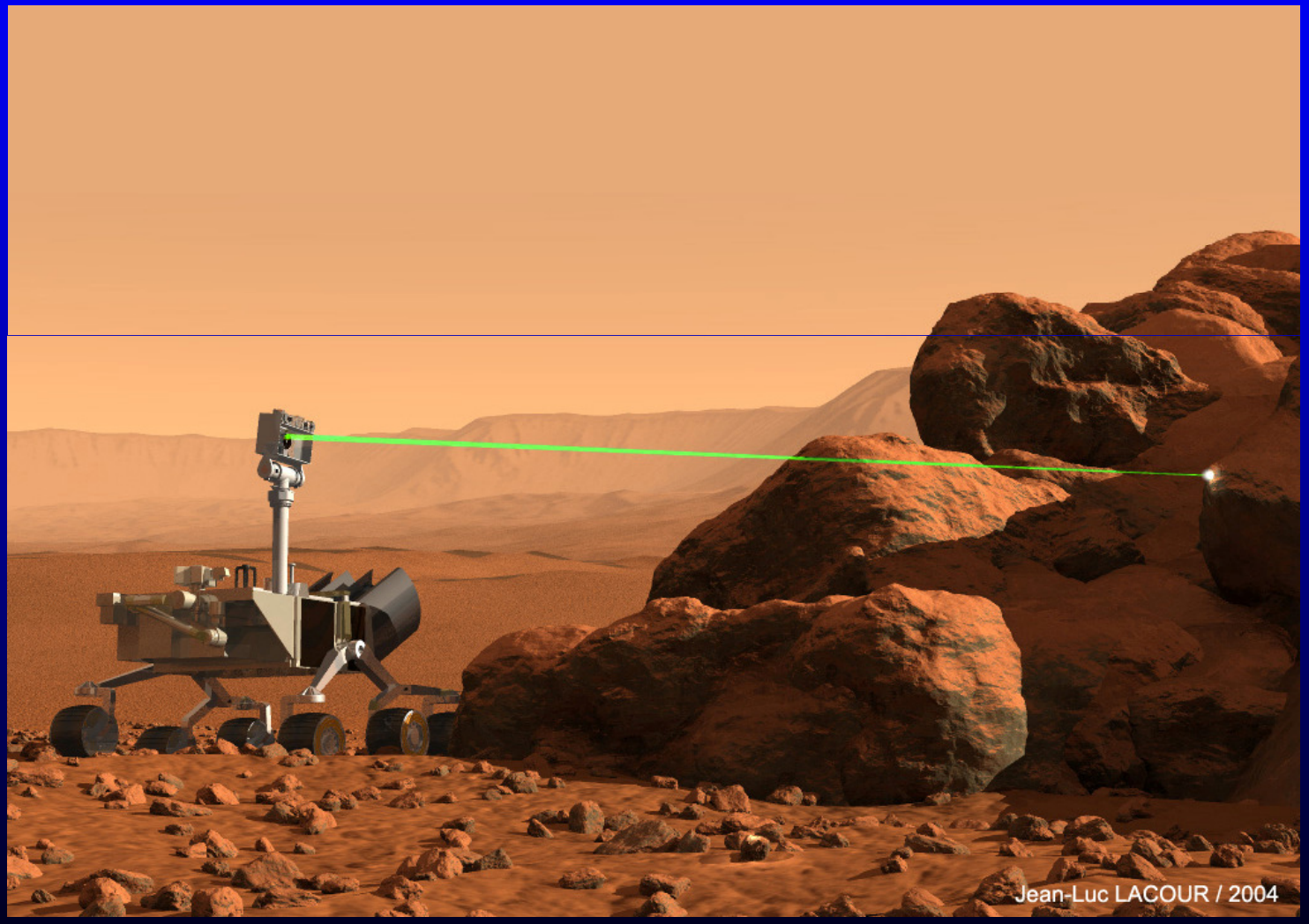


Radioisotope thermoelectric generator



- Uses Plutonium 238 (Non weapons grade!) as the heat source.

Cam Lasing System

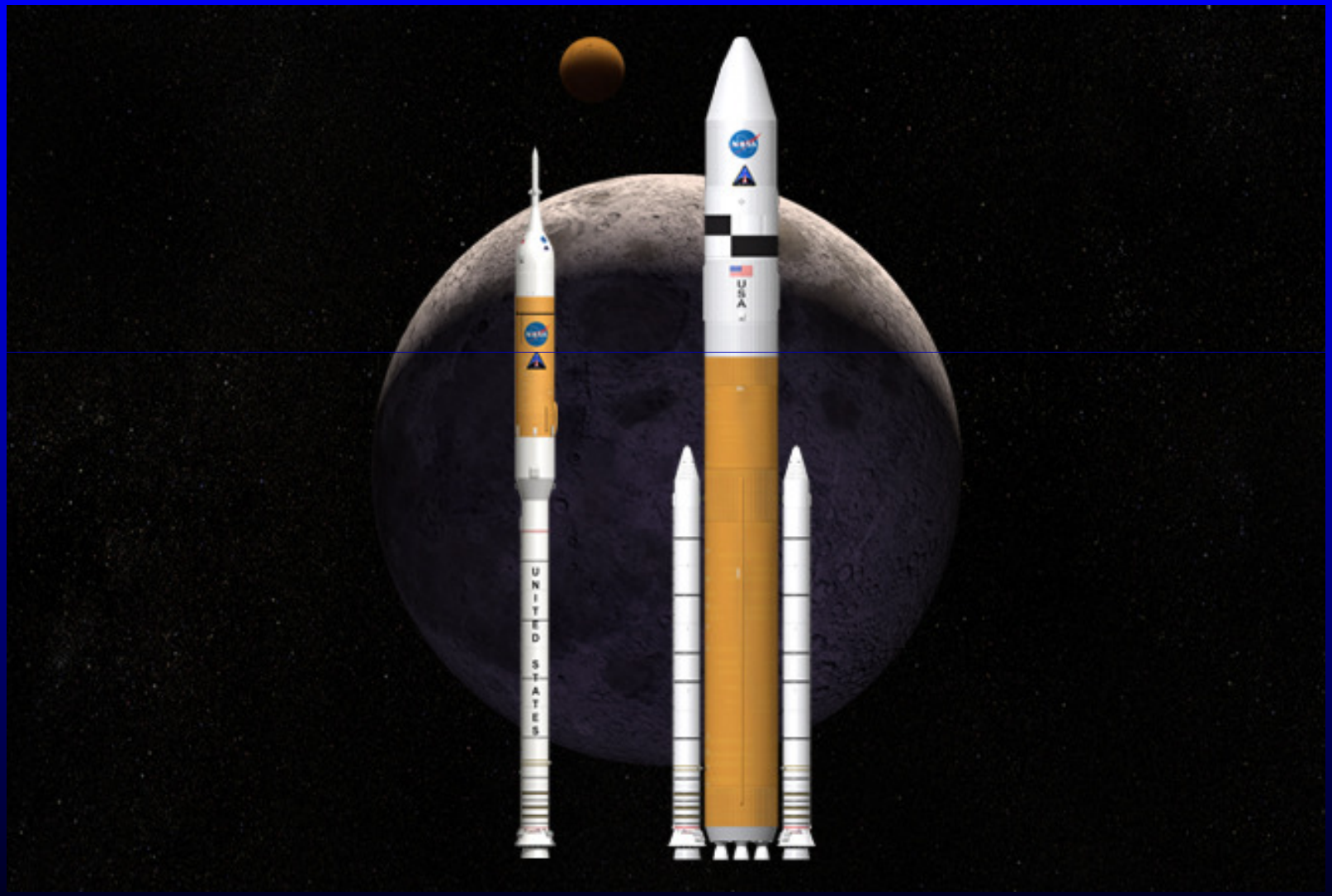


Manned Mission to Mars?

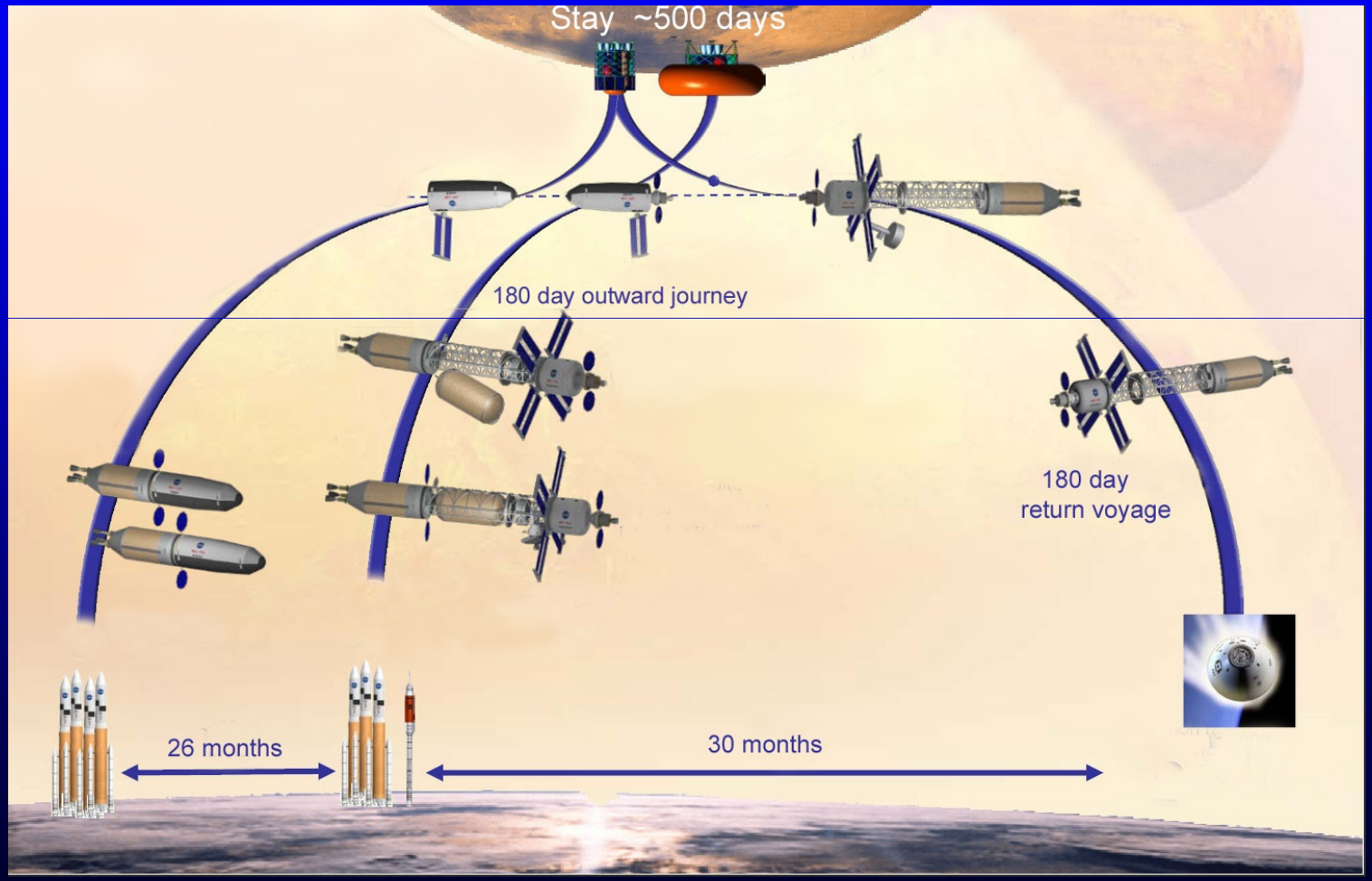
Constellation Program

Cancelled in January 2010 by President Obama

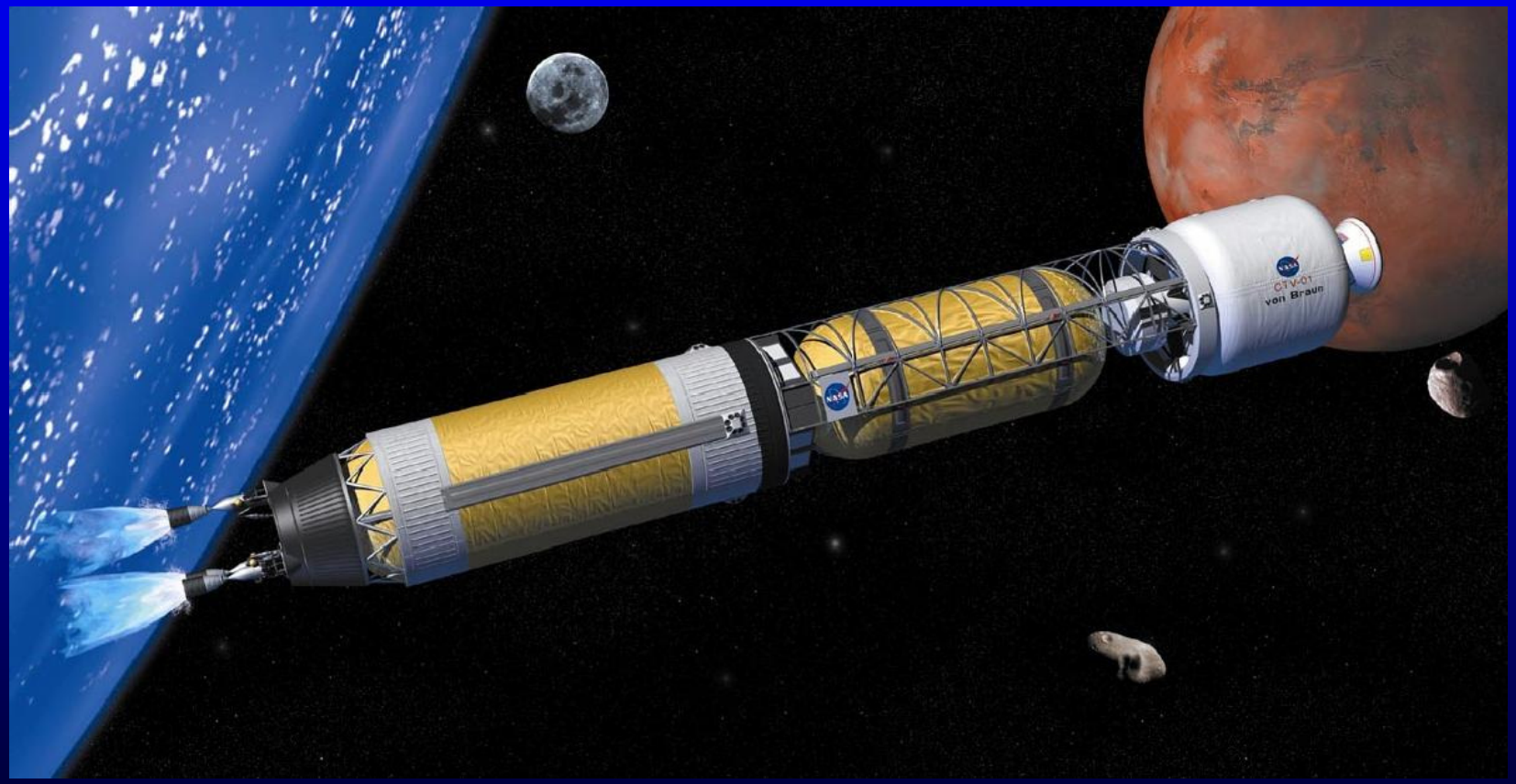
Aries I and IV



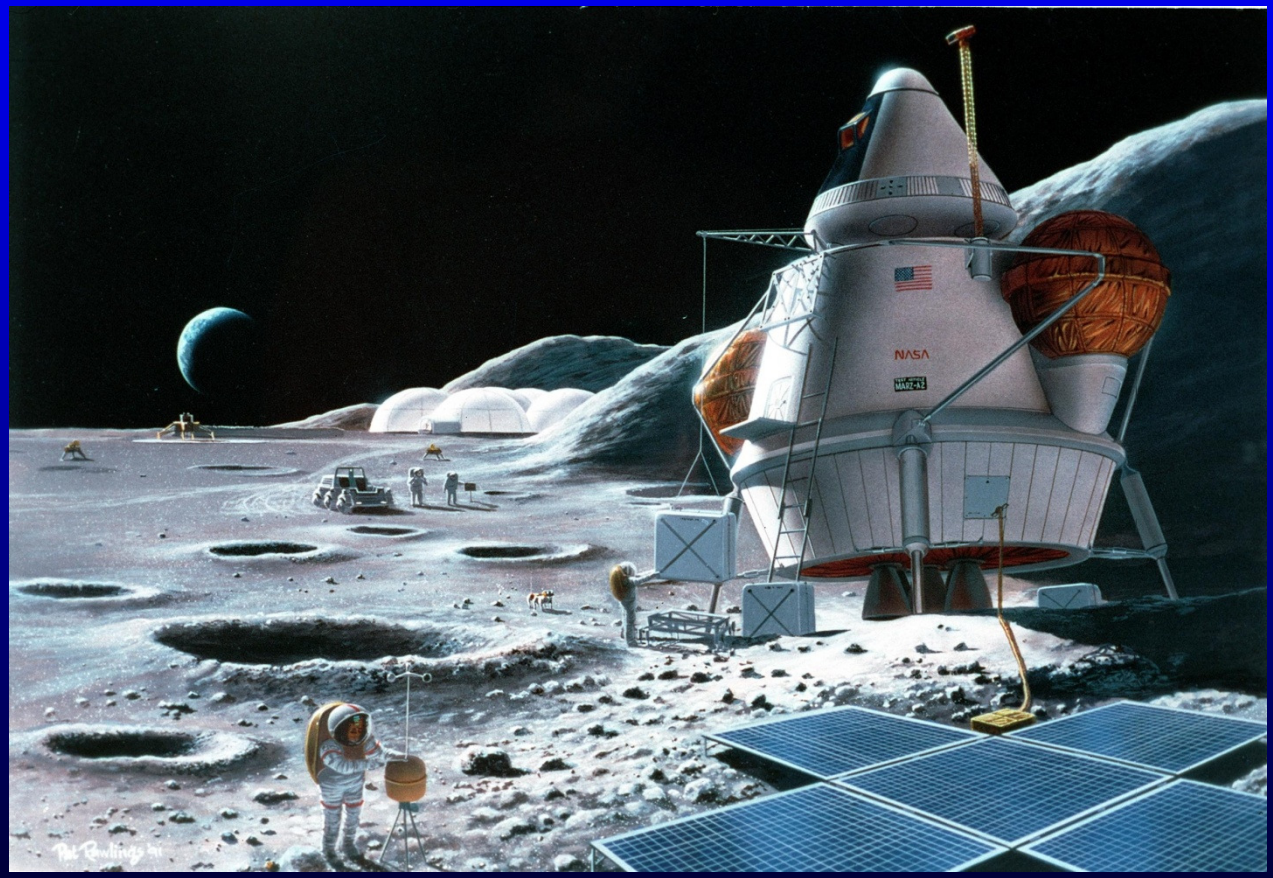
Flight Plan


Stay ~500 days
180 day outward journey
180 day
return voyage
26 months
30 months

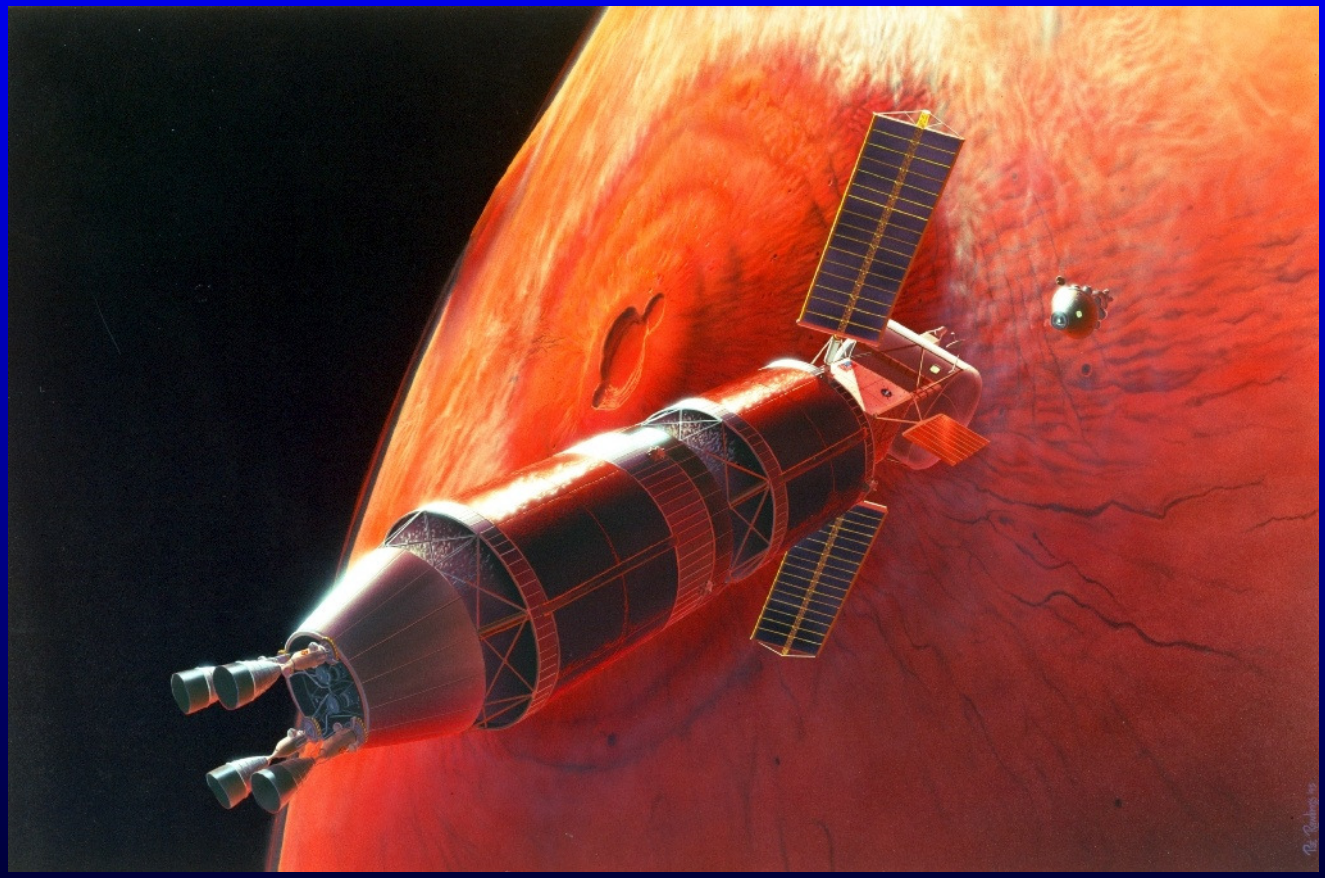
En route to Mars



Mars Base

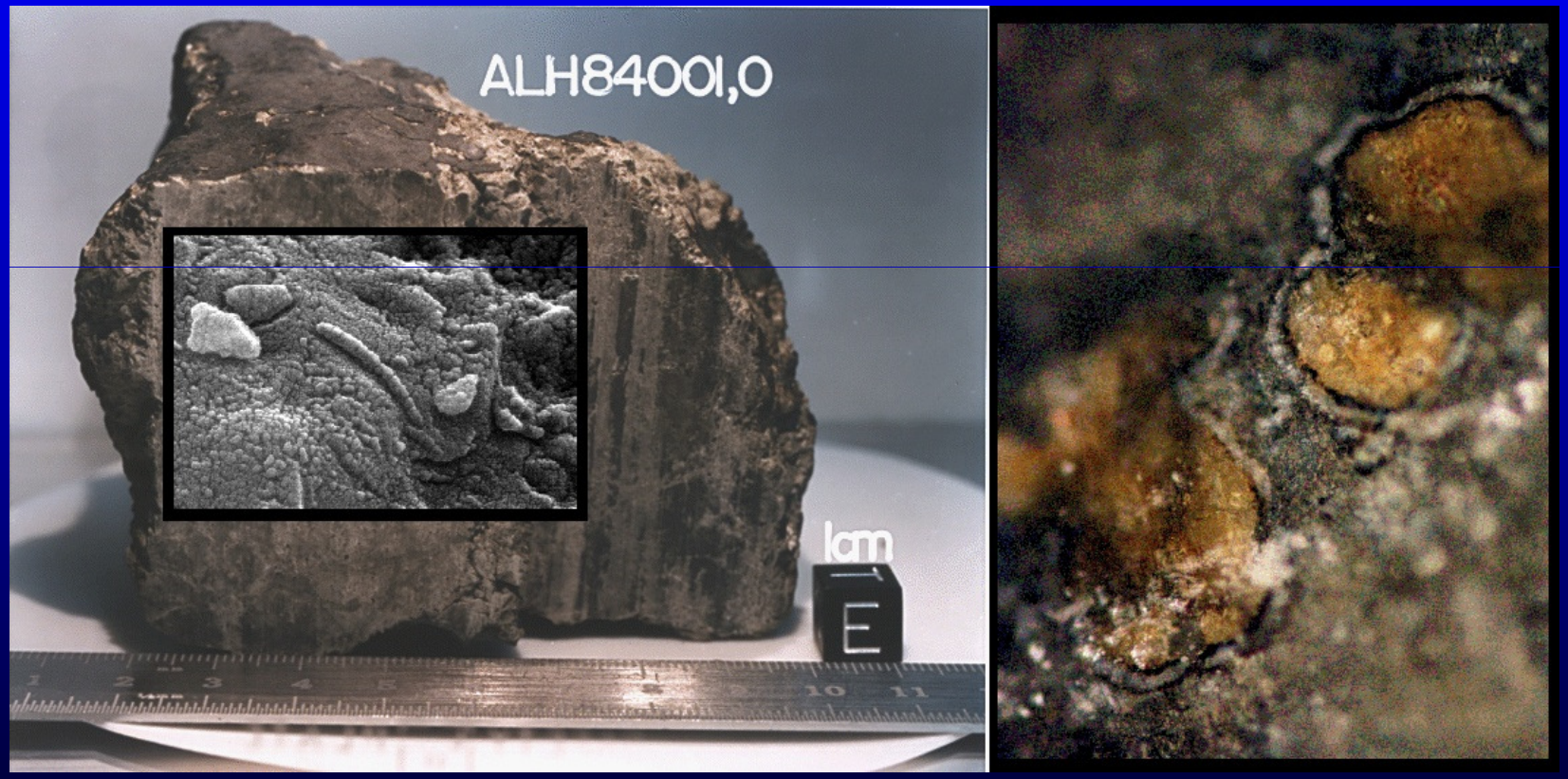


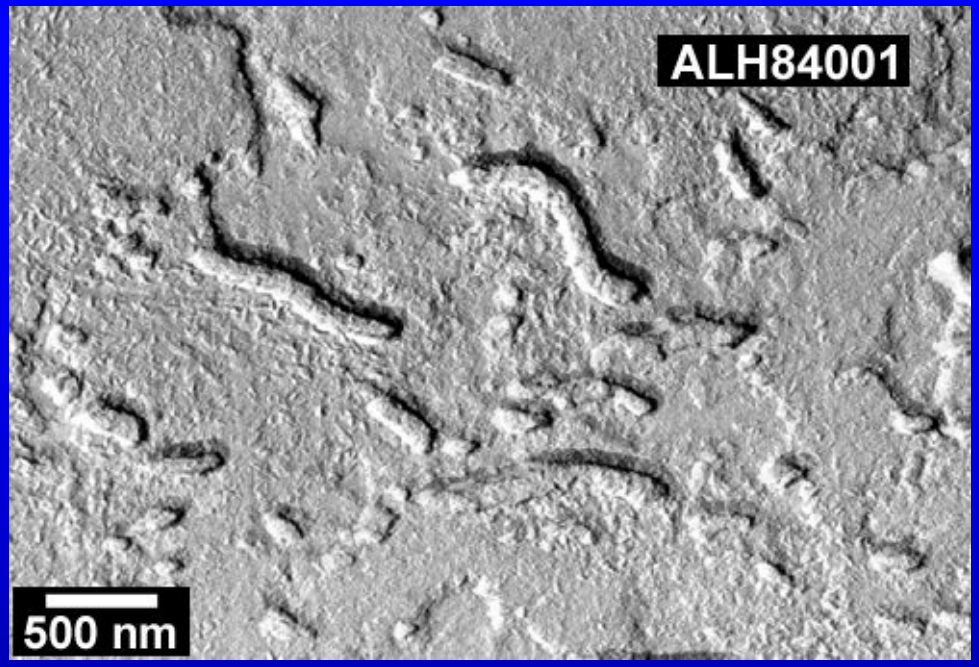
Rendezvous for return home

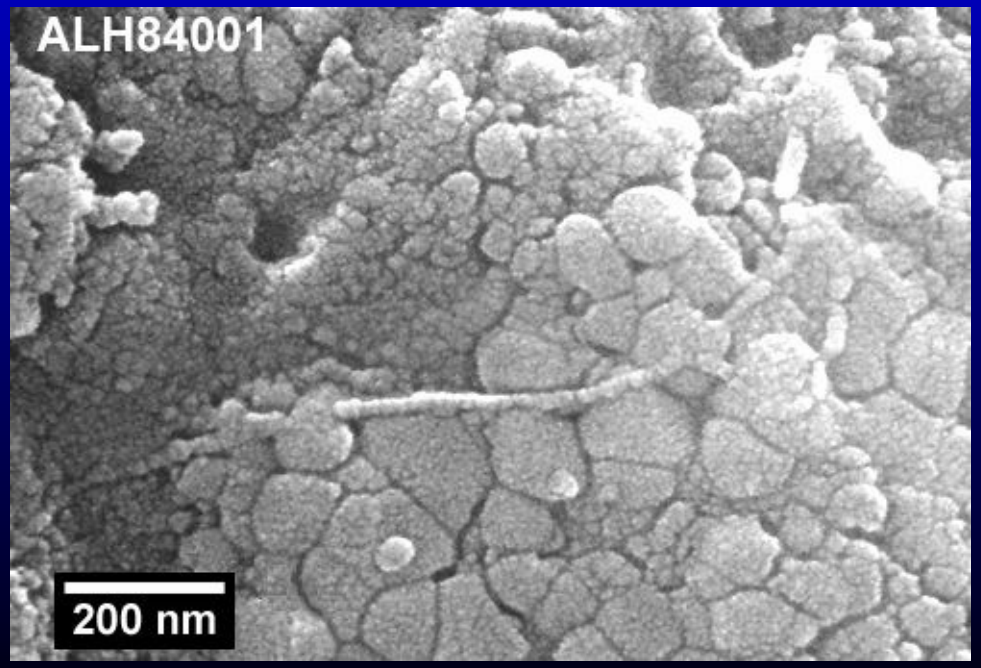


Rocks from Mars

Could they hold evidence of past life?

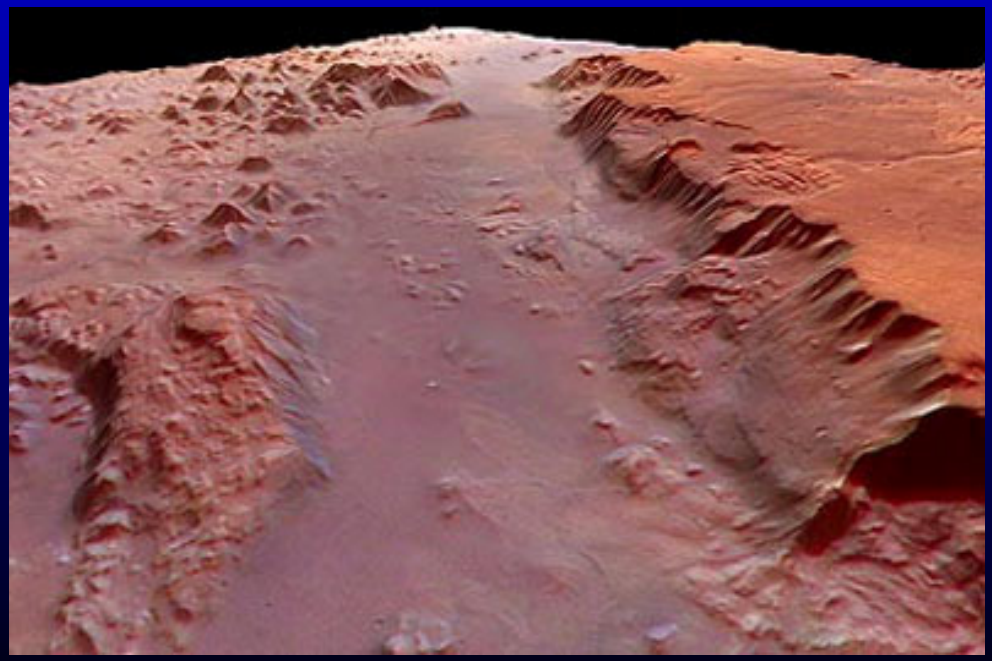

ALH84001,0
1cm
E

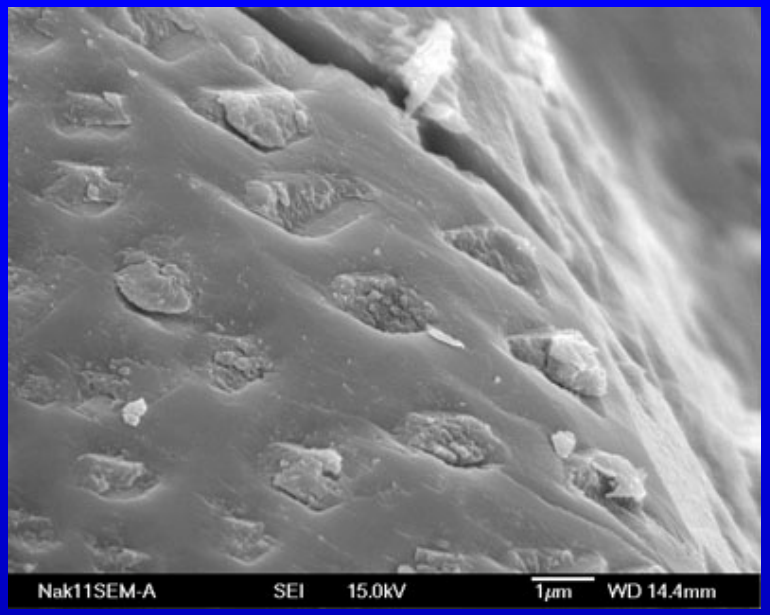

ALH84001
500 nm

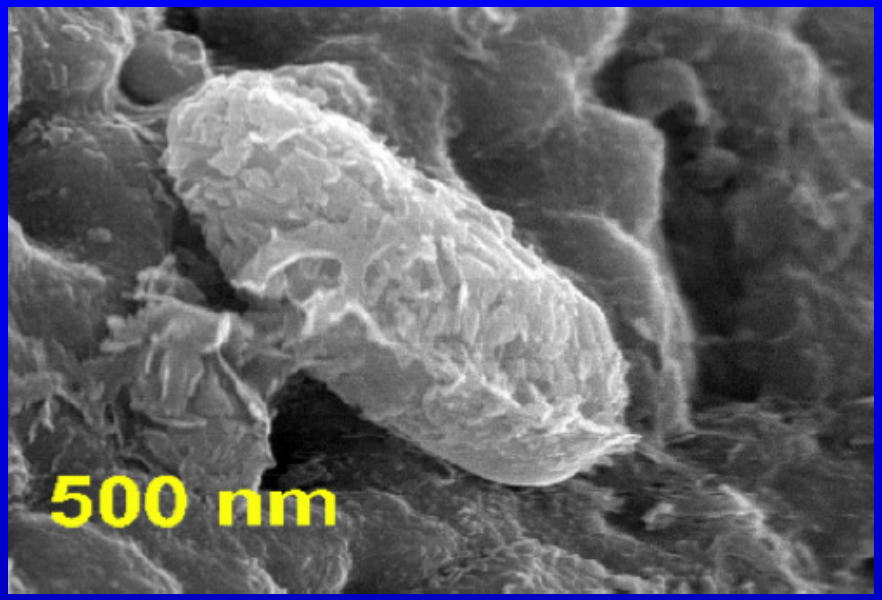

ALH84001
200 nm

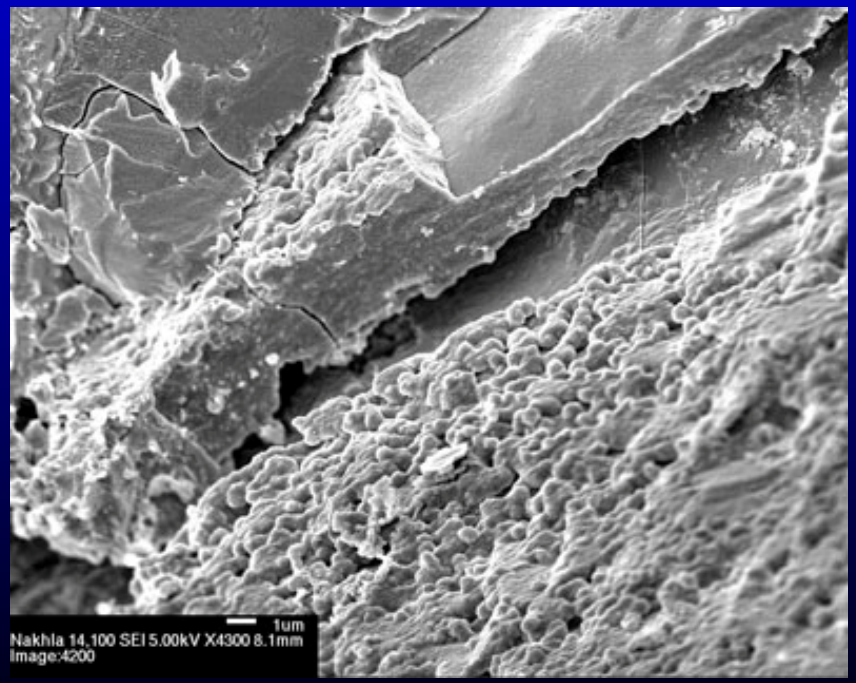
Nakhla Meteorite

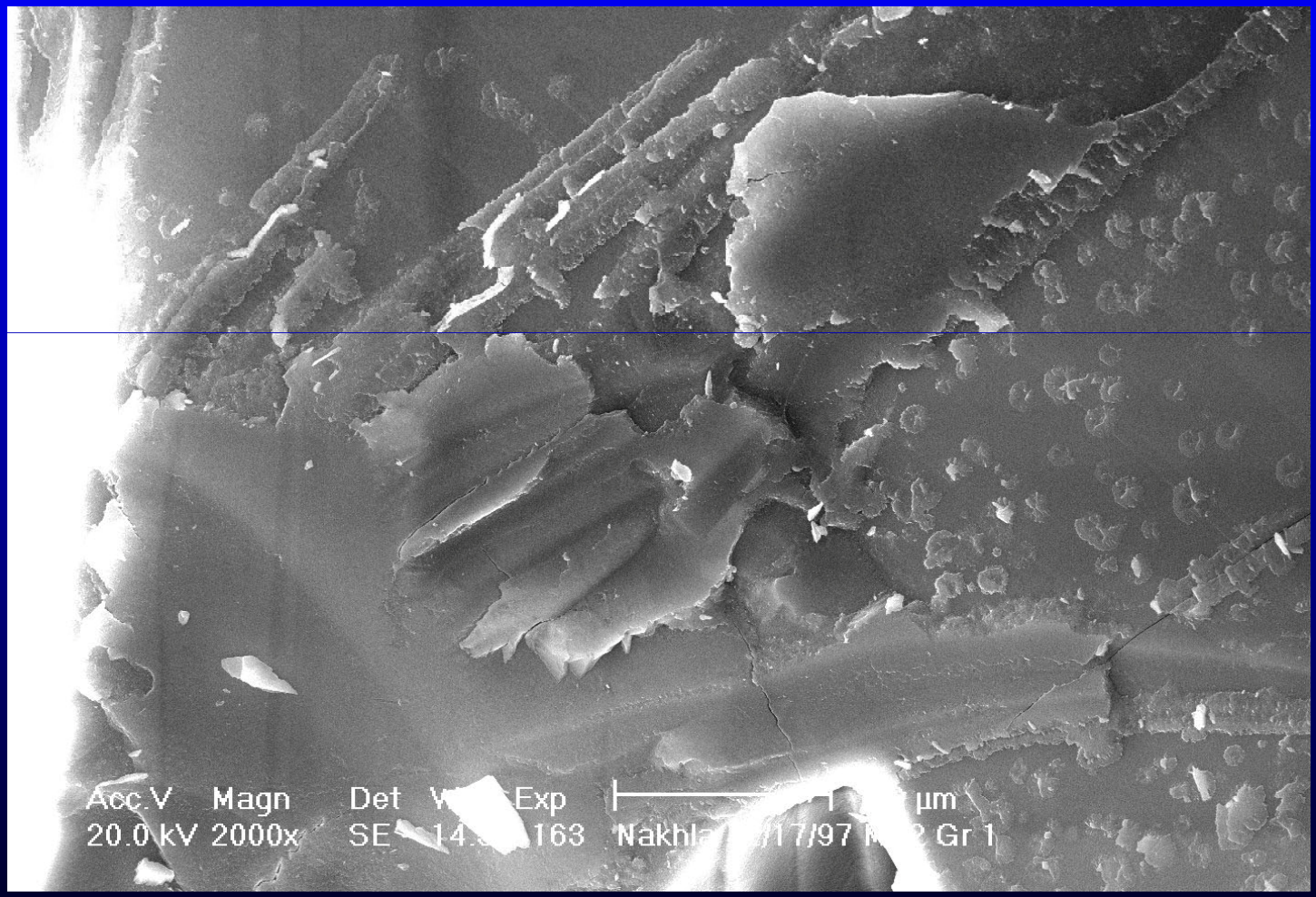
Fell June 28th 1911 in Egypt



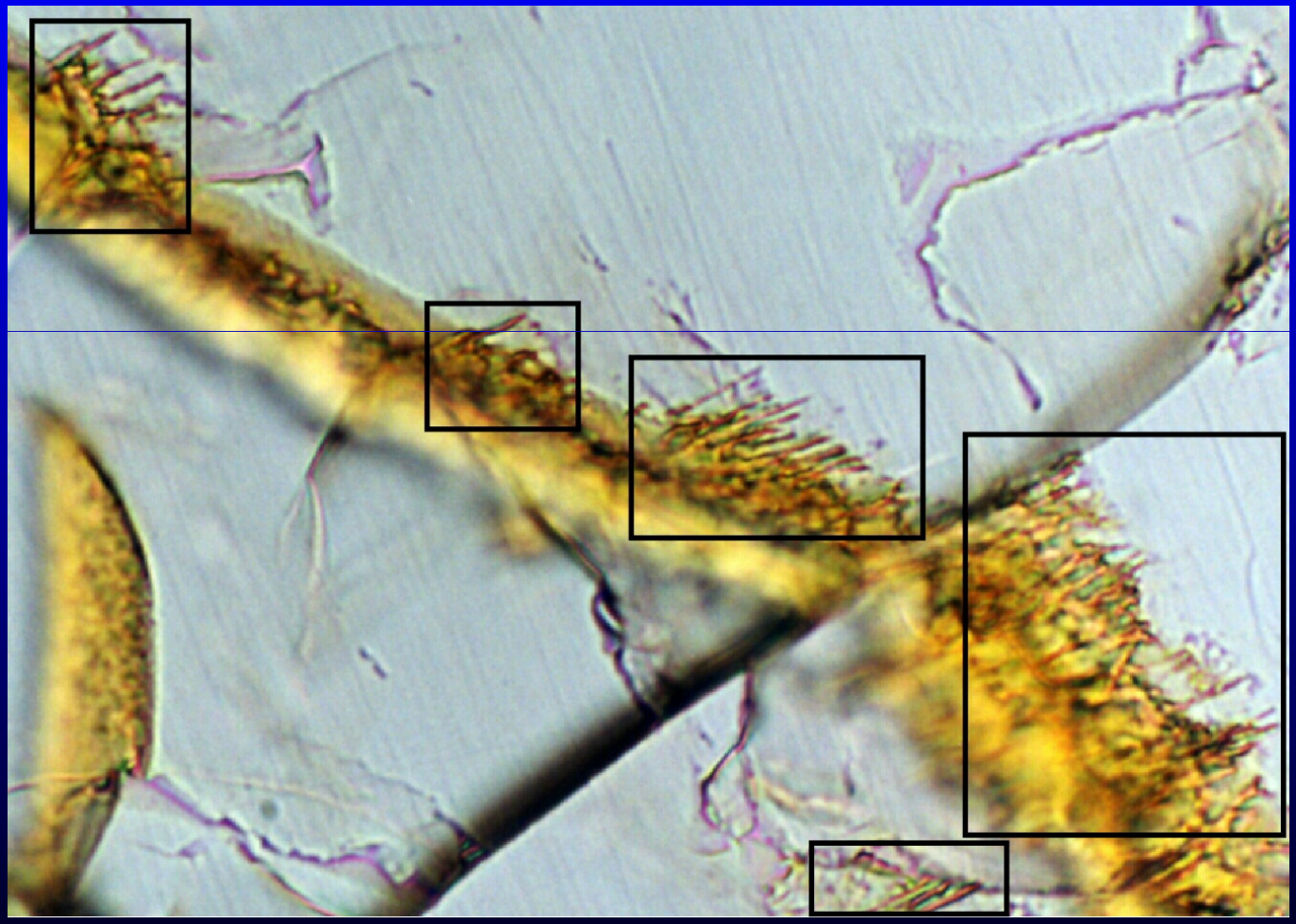

Nak11SEM-A
SEI
15.0kV
1μm
WD 14.4mm


500 nm


1um
Nakhla 14,100 SEI 5.00kV X4300 8.1mm
Image:4200


Acc.V Magn Det Exp µm
20.0 kV 2000x SE 163 Nakhla 17/97 Gr 1

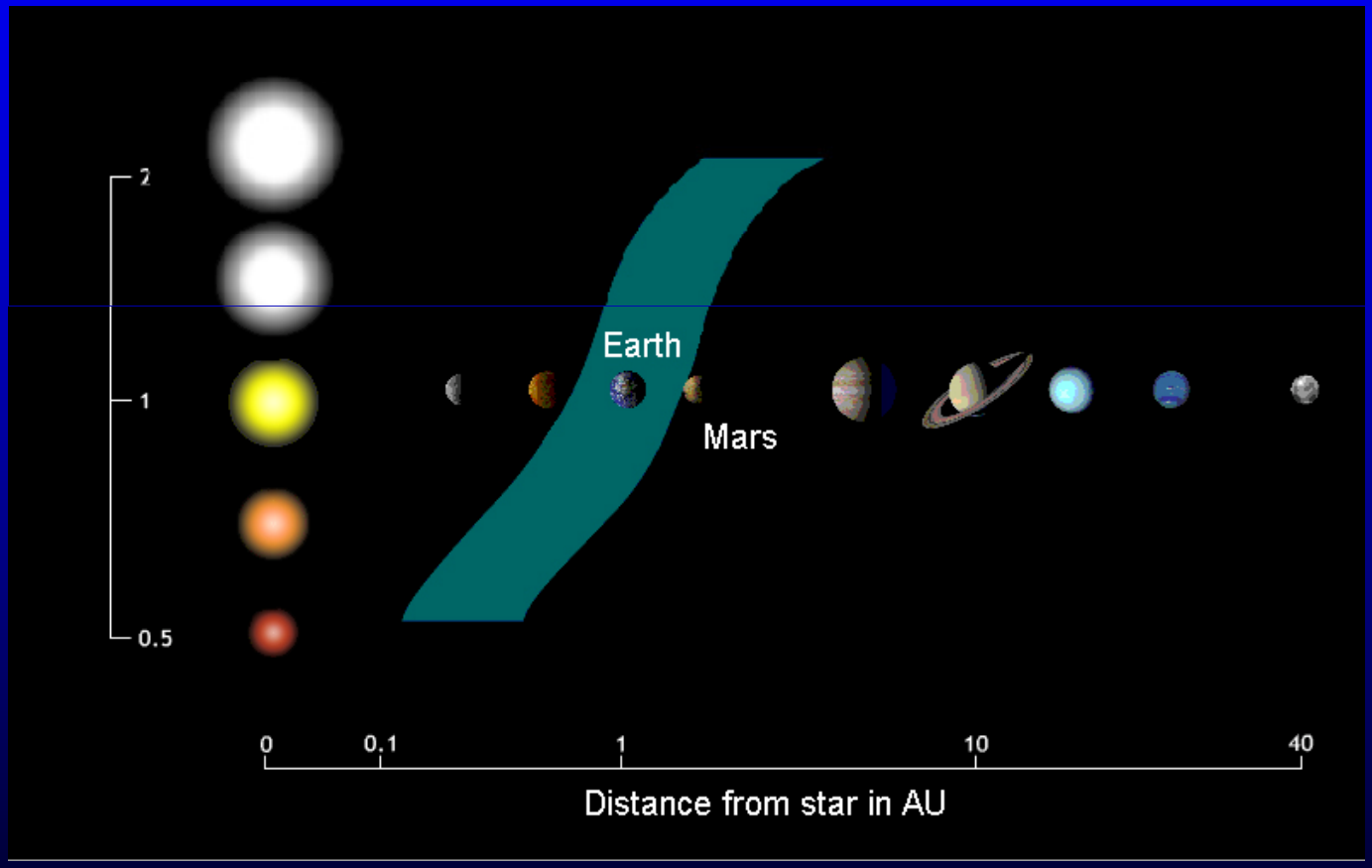
10 micron “tubes”

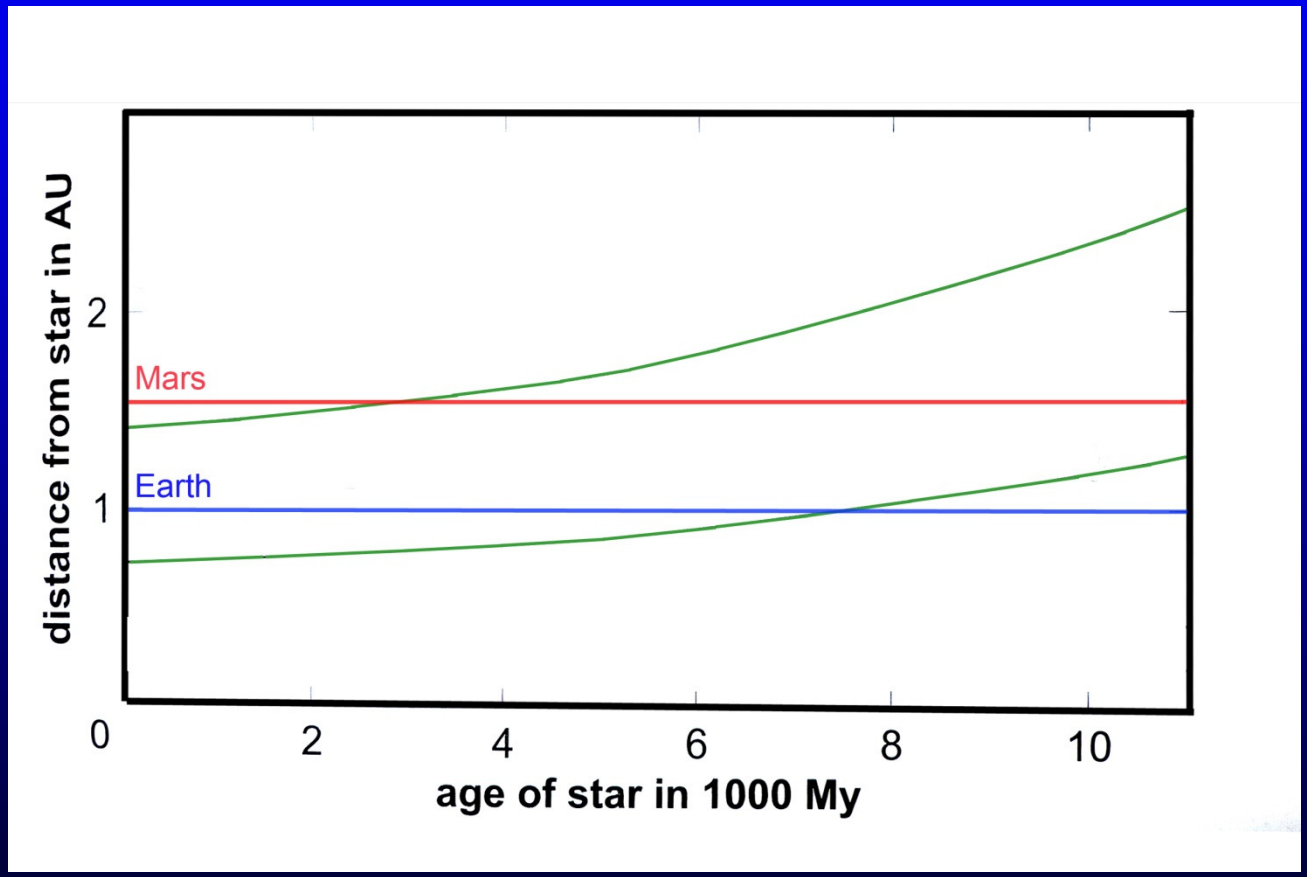


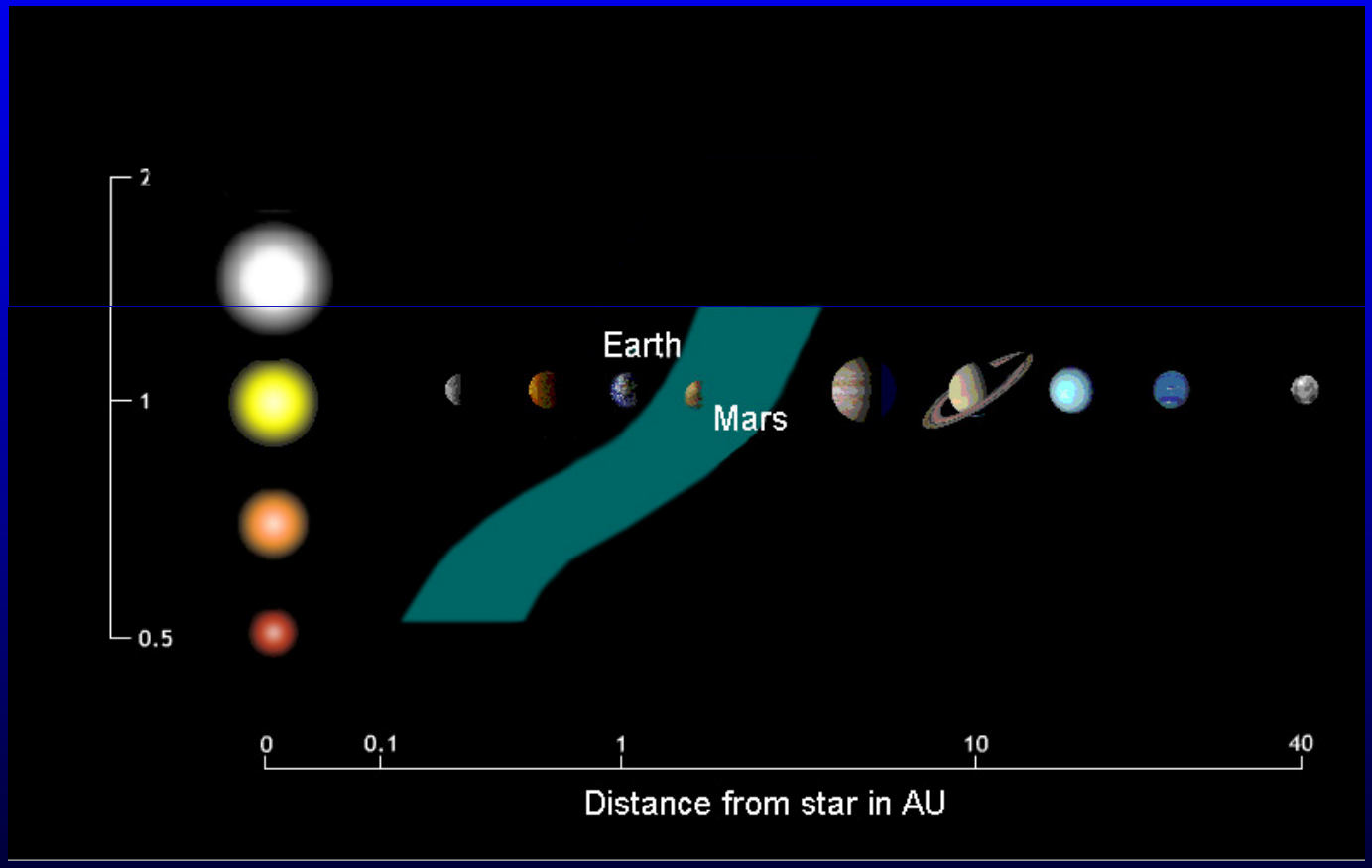
The Far Future

Good for Mars

Not so good for Earth


2
1
0.5
Earth
Mars
0
0.1
1
10
40
Distance from star in AU


distance from star in AU
2
1
0
Mars
Earth
2
4
6
8
10
age of star in 1000 My


2
1
0.5
Earth
Mars
0
0.1
1
10
40
Distance from star in AU

Could Mars become a lifeboat for the human race?