Exploring The Columbia Hills of Mars

Dr. James Rice
Mars Rover Scientist

Spirit Sol 1332

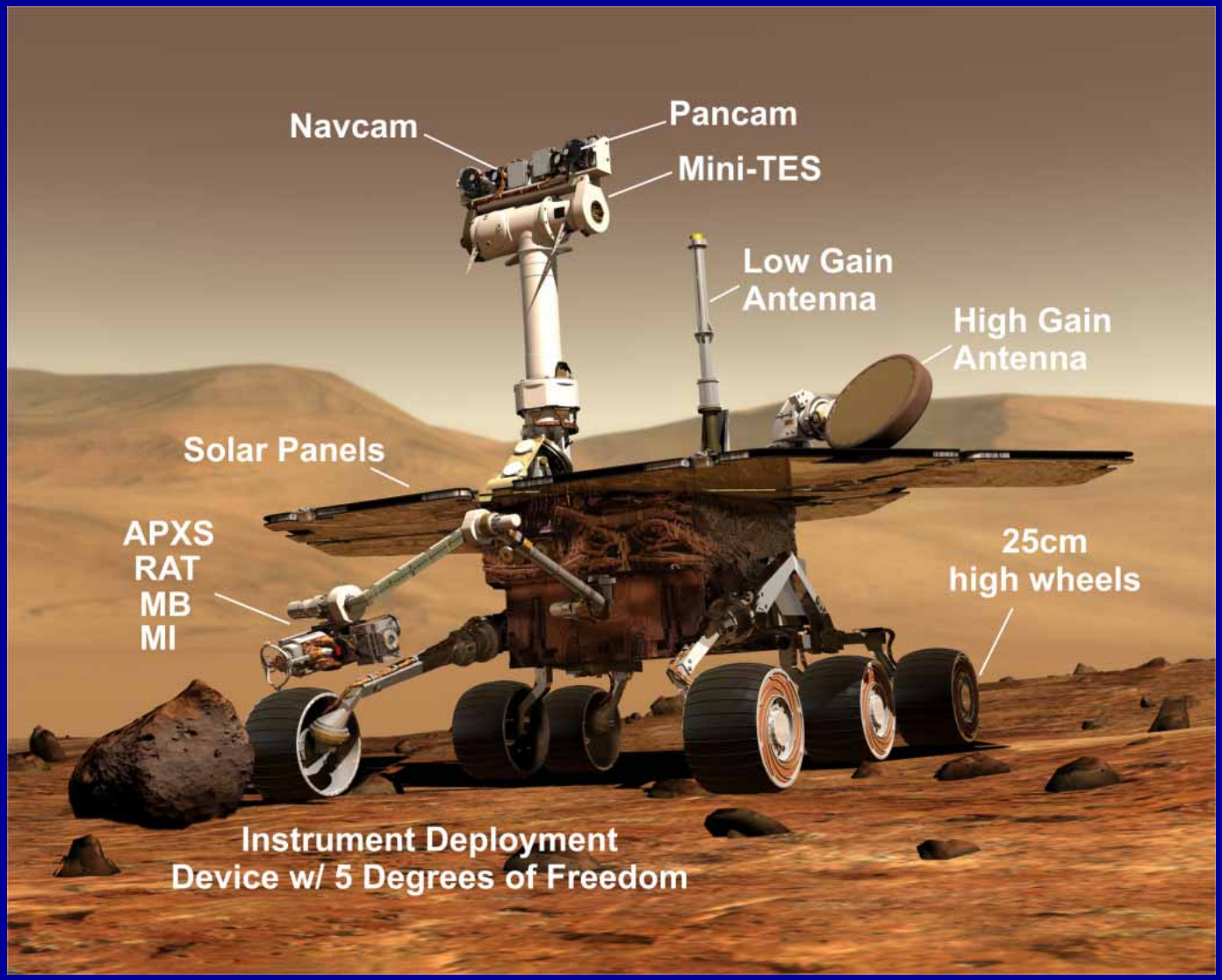
7.2 km traversed thus far

MER Science Goal

"Determine the aqueous, climatic, and geologic history of two sites on Mars where conditions may have been favorable to the preservation of evidence of pre-biotic or biotic processes."

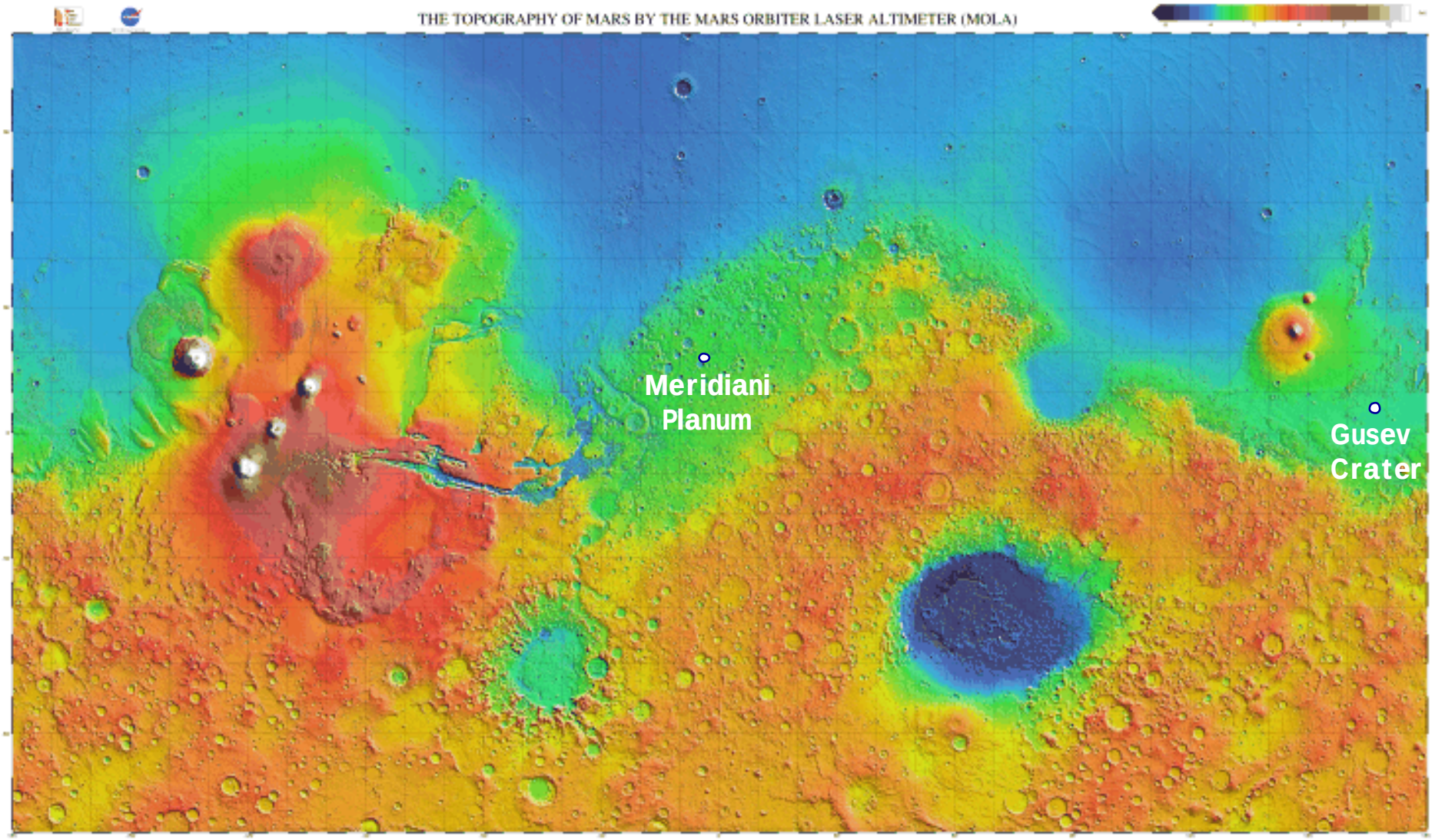
Mars Exploration Rover Launches: June 10 and July 7, 2003

Mars Exploration Rover

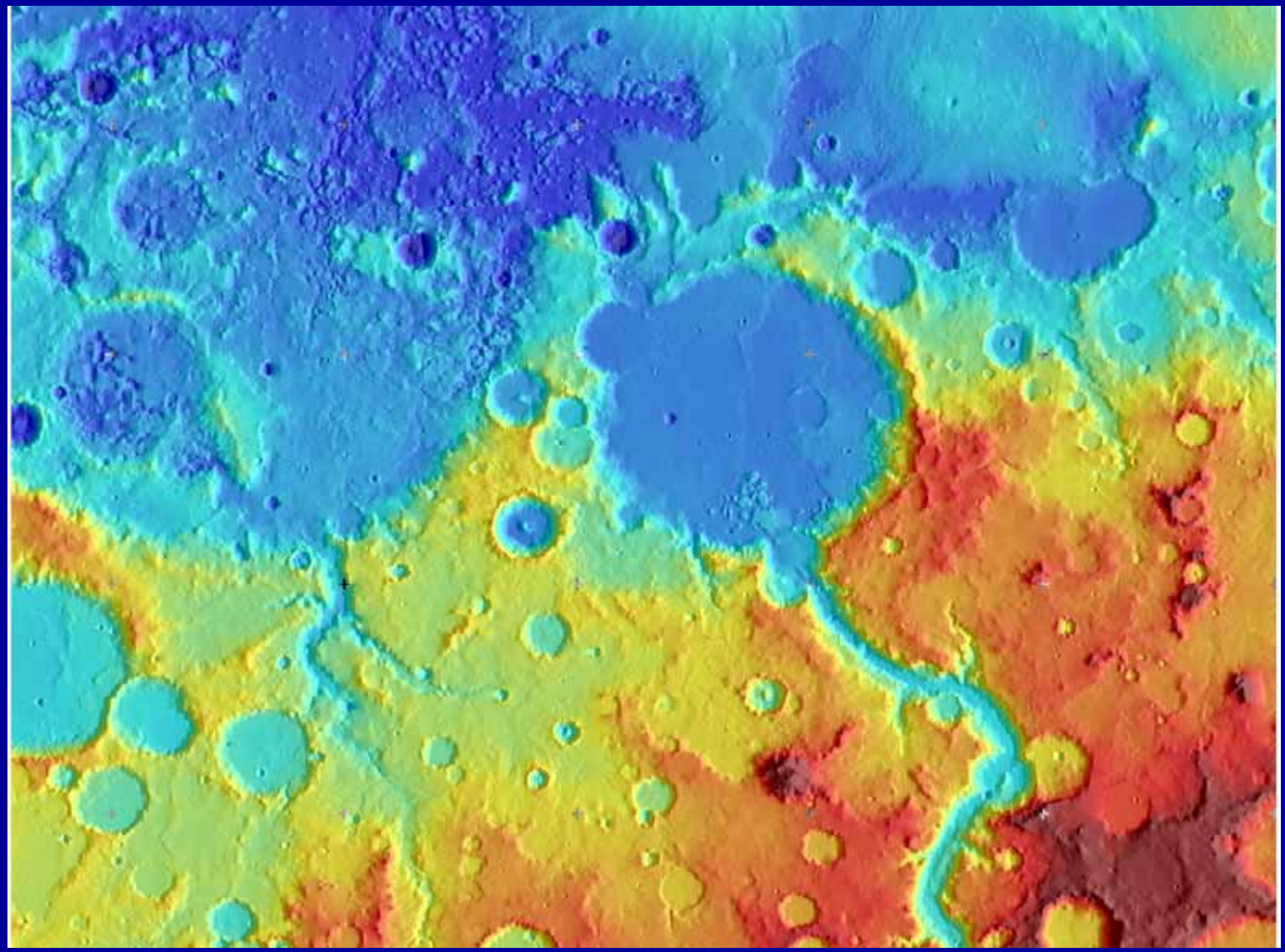


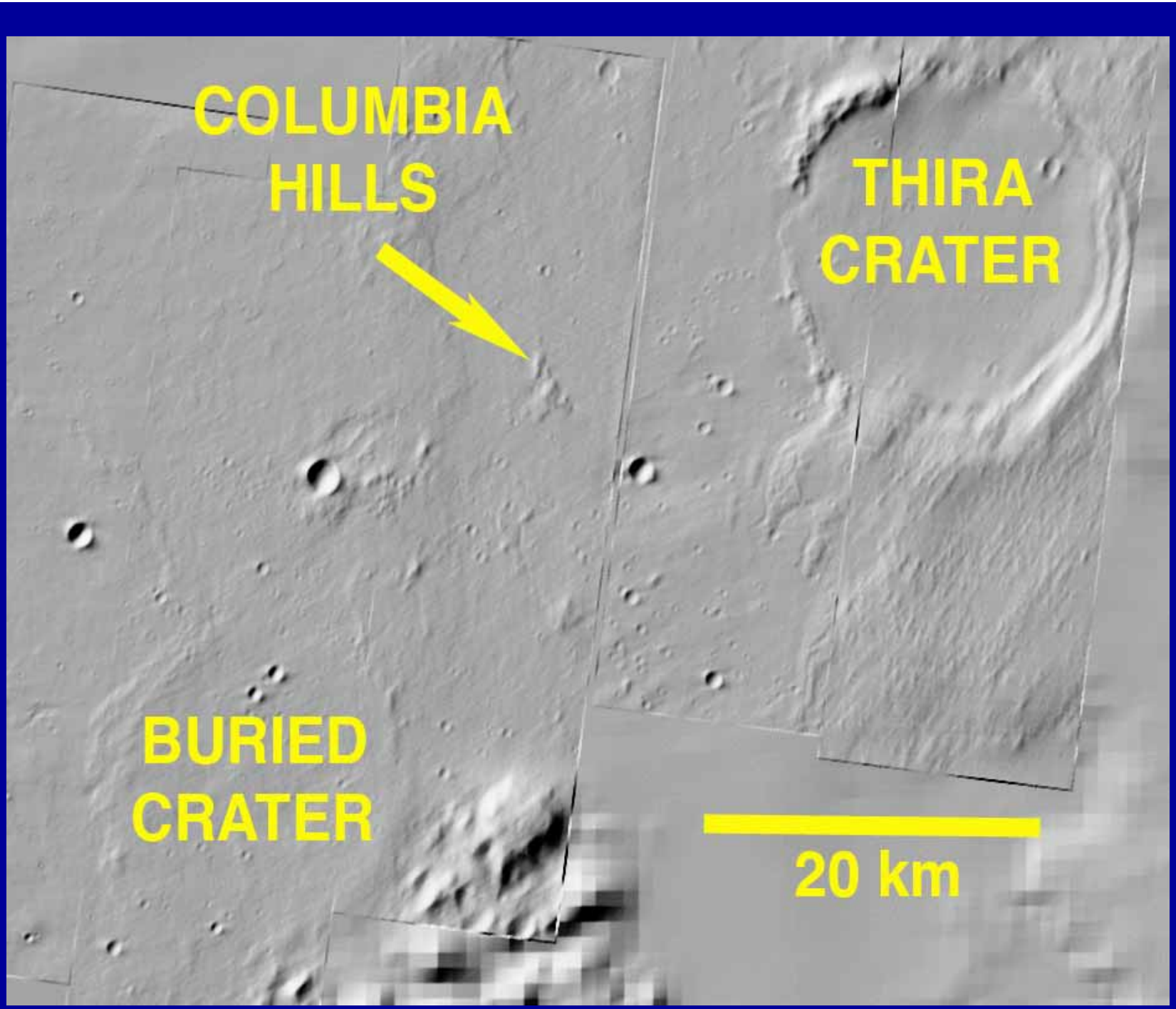
The Mars Exploration Rover Mission

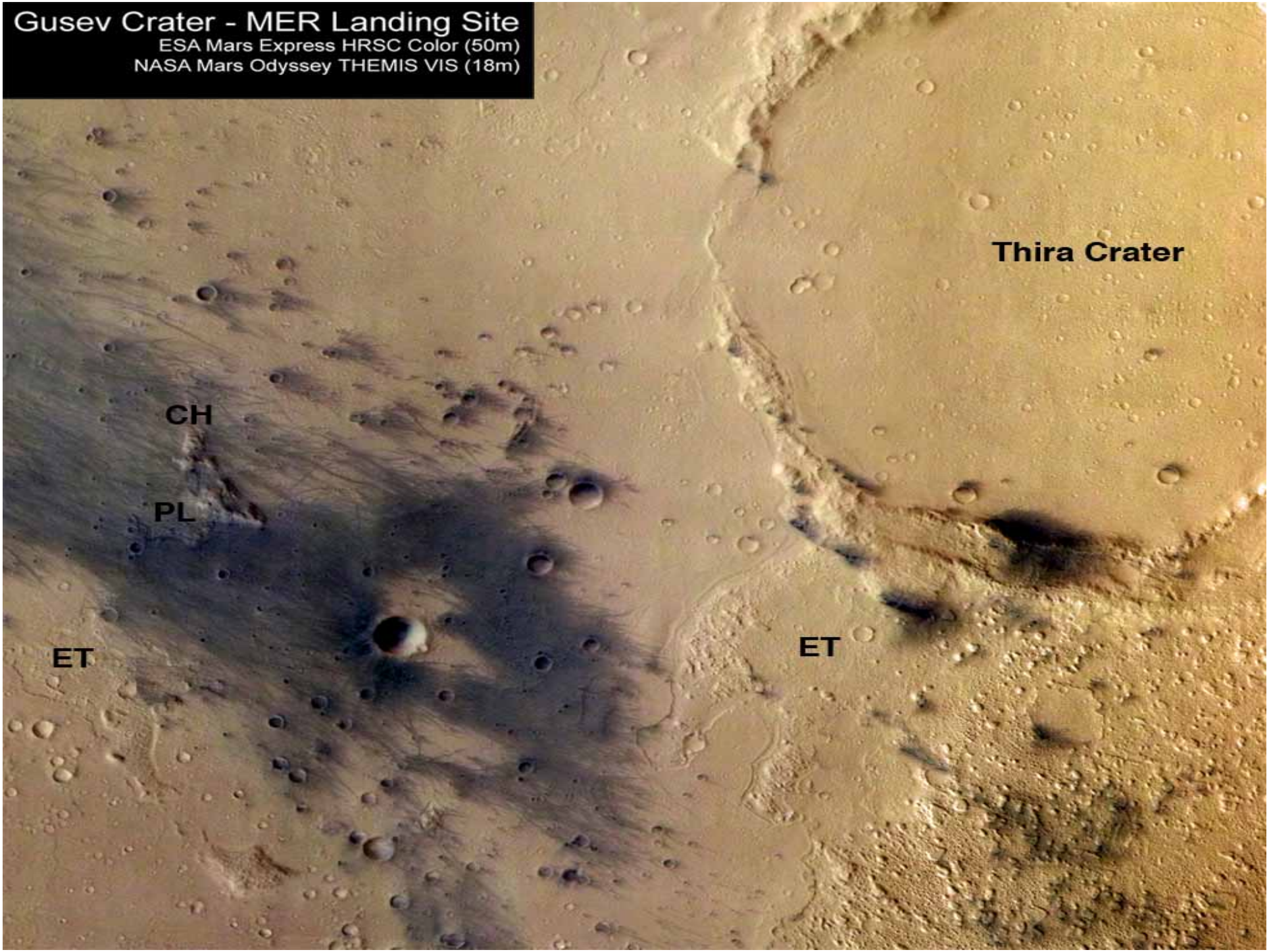
The Landing Sites

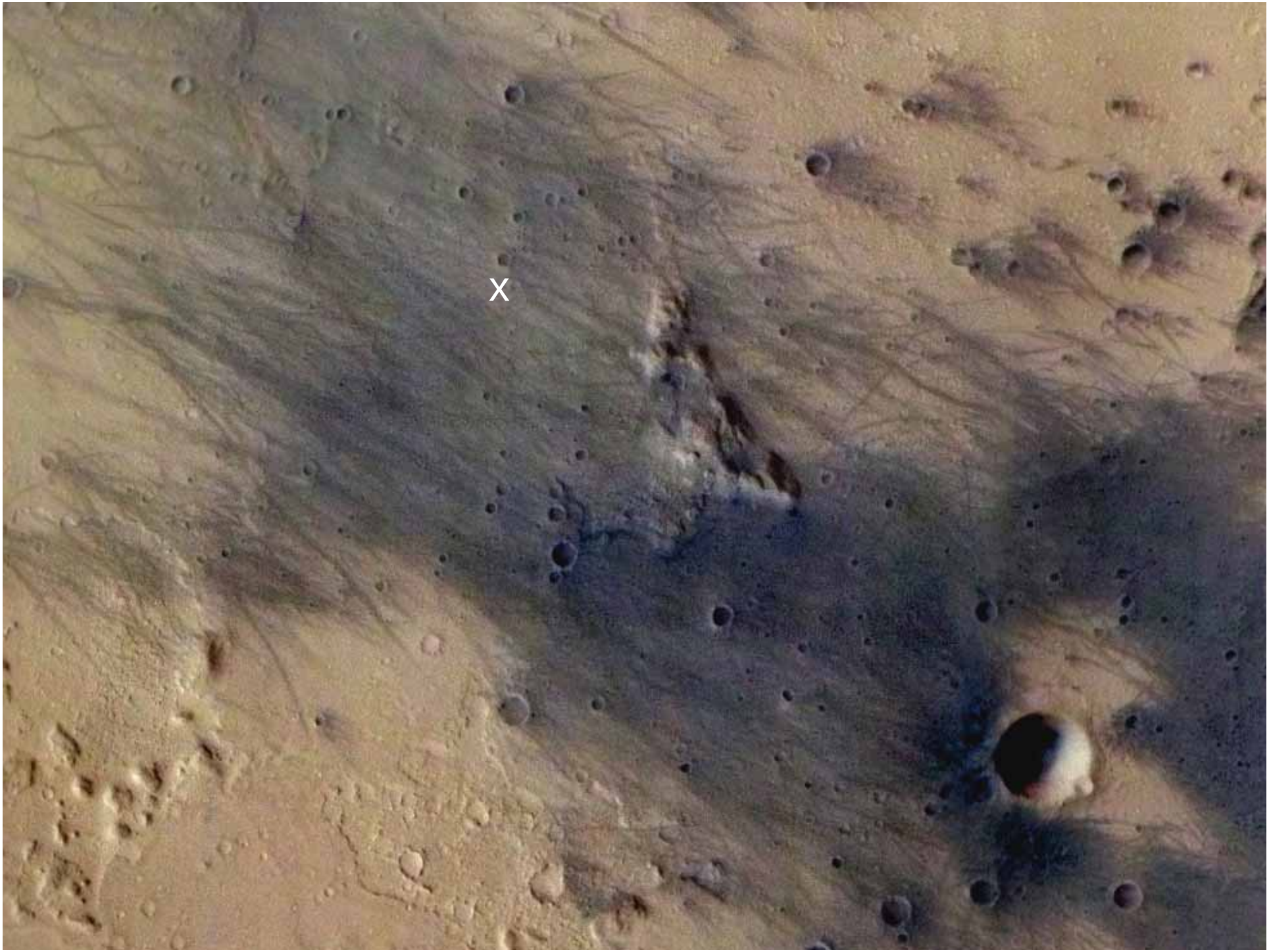


Spirit: Gusev Crater

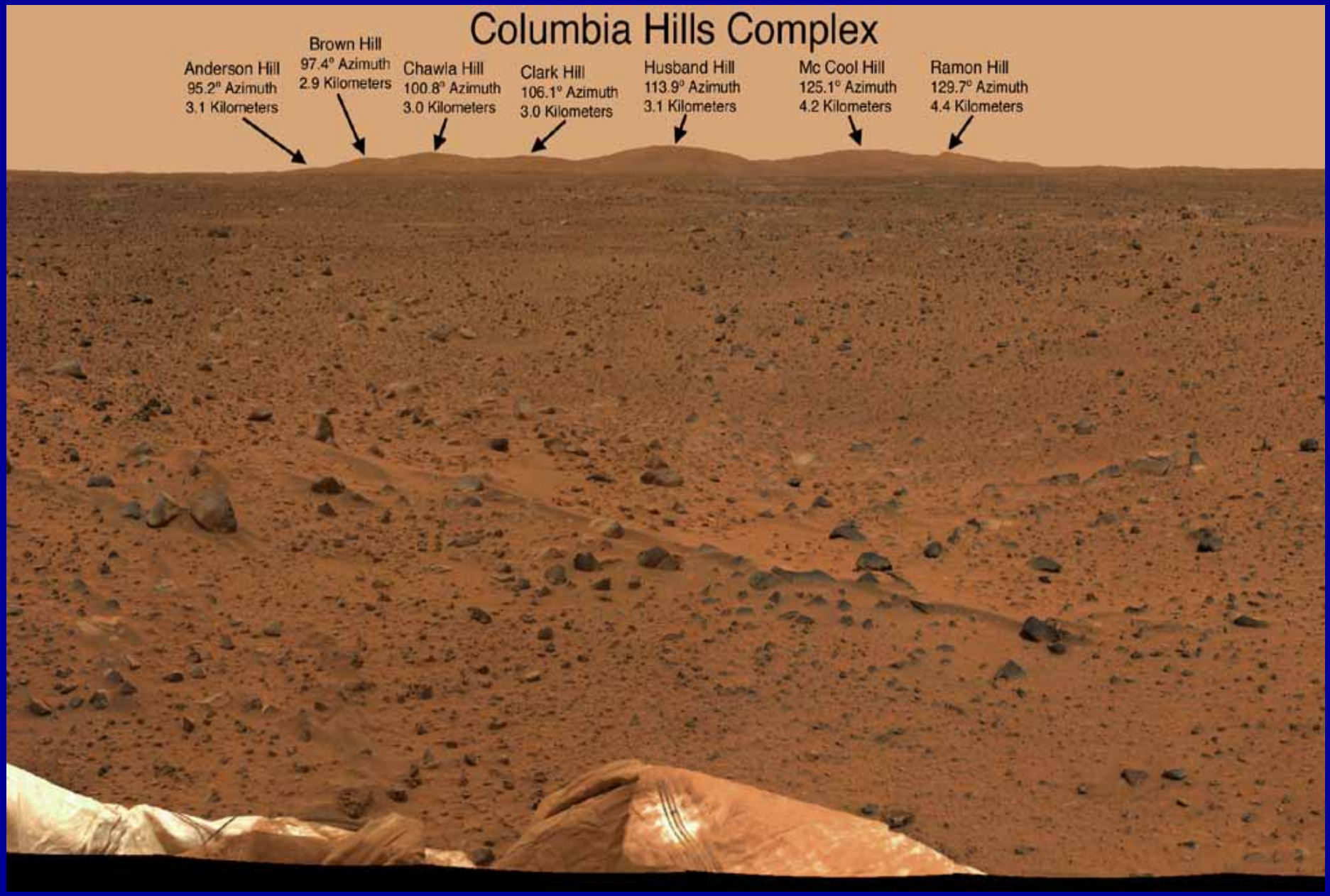



COLUMBIA
HILLS
THIRA
CRATER
BURIED
CRATER
20 km

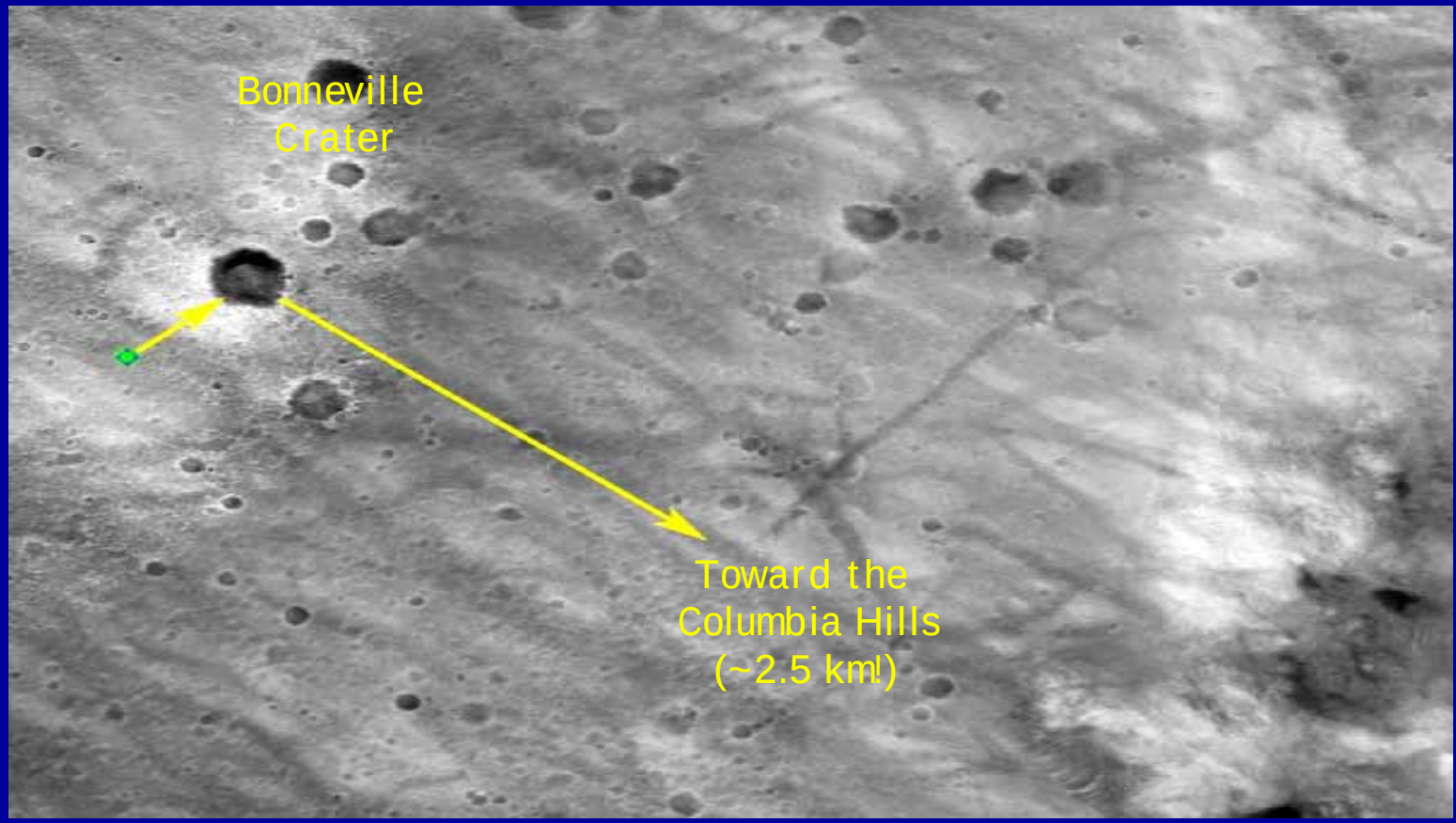

Gusev Crater - MER Landing Site
ESA Mars Express HRSC Color (50m)
NASA Mars Odyssey THEMIS VIS (18m)
Thira Crater
CH
PL
ET
ET

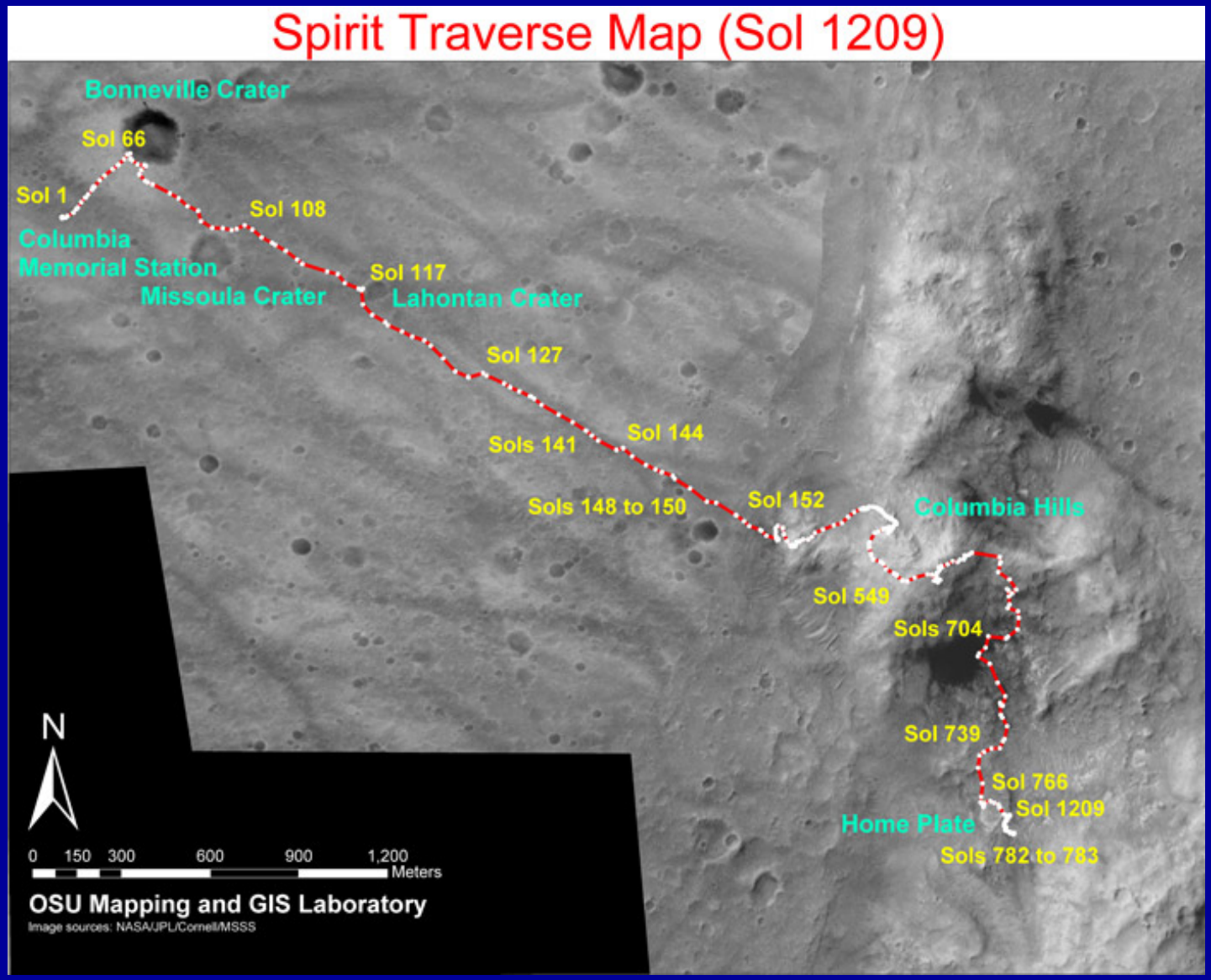



IN
MEMORIAM
TO THE CREW OF THE
SPACE SHUTTLE COLUMBIA
STS-107 : FEBRUARY 1, 2003
Rick D. Husband
William C. McCool
Michael P. Anderson
Kalpana Chawla
David M. Brown
Laurel B. Clark
Ilan Ramon
NASA


Columbia Hills Complex
Anderson Hill
95.2° Azimuth
3.1 Kilometers
Brown Hill
97.4° Azimuth
2.9 Kilometers
Chawla Hill
100.8° Azimuth
3.0 Kilometers
Clark Hill
106.1° Azimuth
3.0 Kilometers
Husband Hill
113.9° Azimuth
3.1 Kilometers
Mc Cool Hill
125.1° Azimuth
4.2 Kilometers
Ramon Hill
129.7° Azimuth
4.4 Kilometers

Gusev Traverse Plan




Spirit Traverse Map (Sol 1209)
Bonneville Crater
Sol 66
Sol 1
Sol 108
Columbia
Memorial Station
Missoula Crater
Sol 117
Lahontan Crater
Sol 127
Sol 144
Sols 141
Sols 148 to 150
Sol 152
Columbia Hills
Sol 549
Sols 704
Sol 739
Sol 766
Sol 1209
Home Plate
Sols 782 to 783
N
0 150 300 600 900 1,200
Meters
OSU Mapping and GIS Laboratory
Image sources: NASA/JPL/Cornell/MSSS

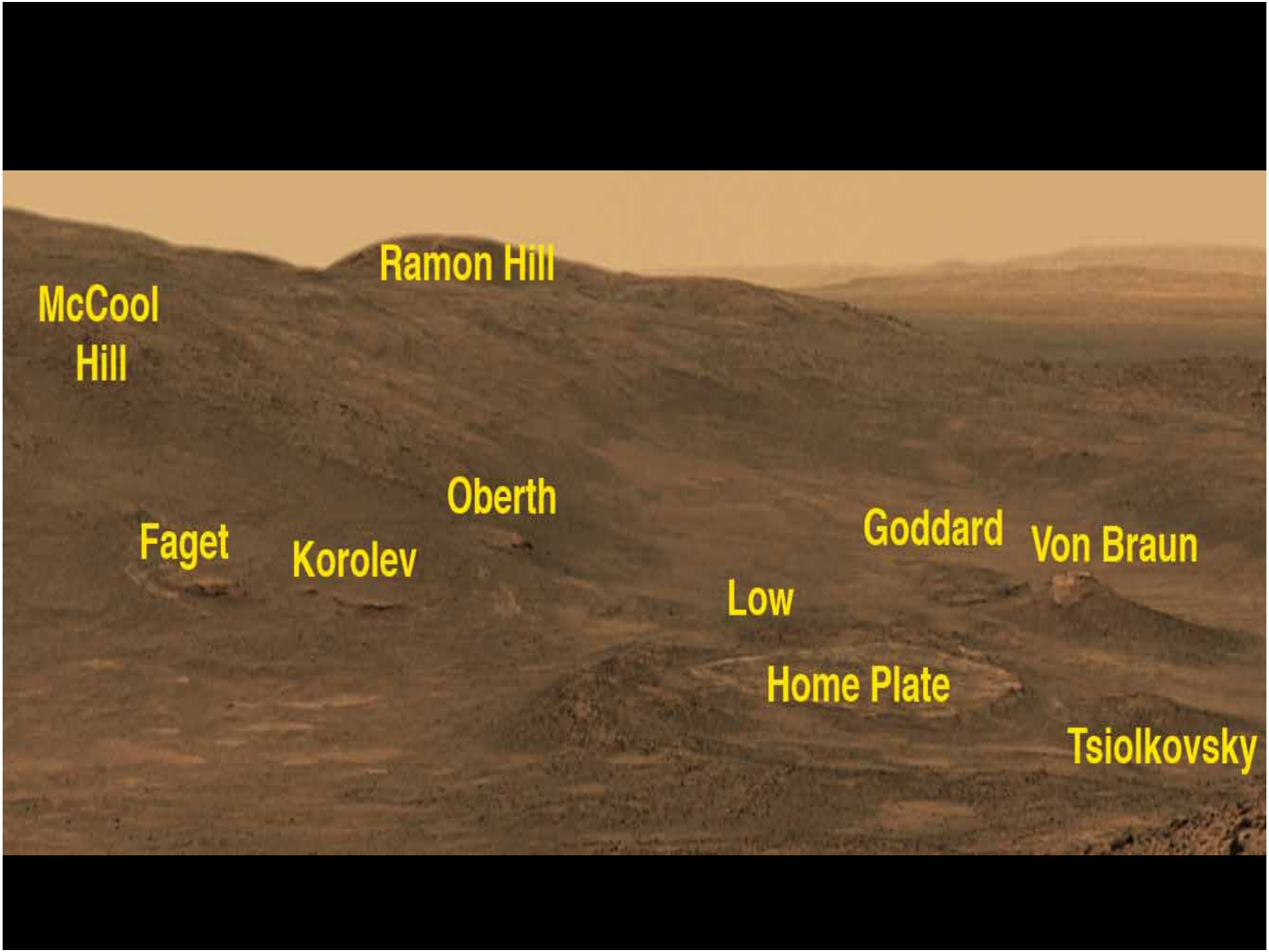
SUCCESS TIP #5

Exceed Expectations.

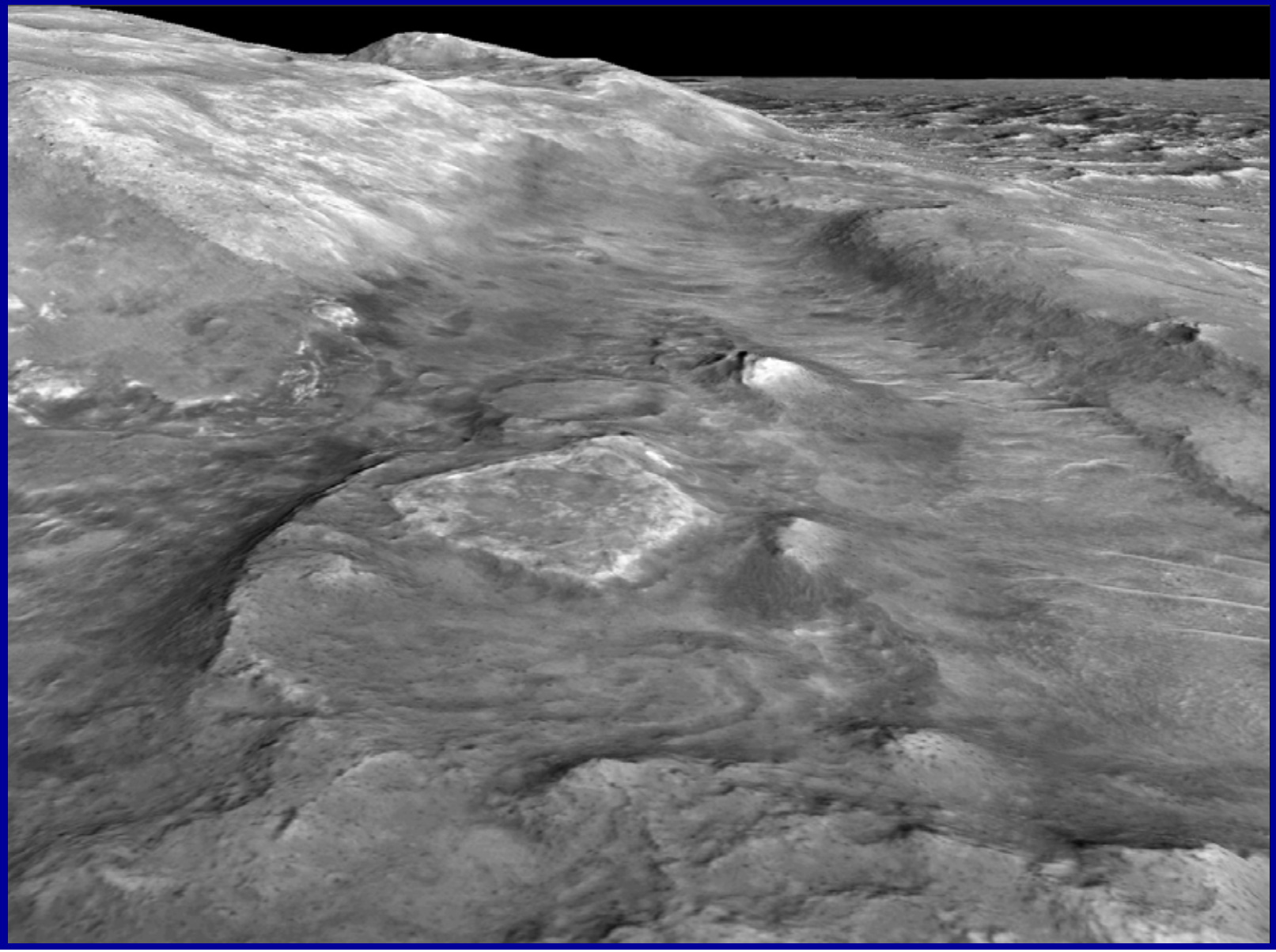
When Spirit first landed in Gusev Crater, the "Columbia Hills" were 1.7 miles (2.7 kilometers) away, and 269 feet (82 meters) above the surrounding plains.

Panoramic camera image with graphic overlay, January 2004. NASA/JPL-Caltech/Cornell

Most people didn't think Spirit would reach the top, but now the rover is on its way down the other side.


Ramon Hill
McCool Hill
Oberth
Faget
Korolev
Goddard
Von Braun
Low
Home Plate
Tsiolkovsky

Looking South



On sol 779 of what was to be a 90-sol mission, Spirit's right-front wheel stopped working.

Front hazard-avoidance camera, sol 780 (March 14, 2006). NASA/JPL-Caltech

The motors that rotate Spirit's wheels have revolved more than 13 million times!

The rover is steadfastly dragging the old wheel to a slope where it can catch enough sunlight to survive the martian winter without “hibernation.”

Navigation camera, March 16, 2006 (sol 782). NASA/JPL-Caltech

Phreatomagmatic Eruptions

Terrestrial phreatomagmatic eruptions occur when ascending magma contacts ground water, ice and or wet sediments resulting in an explosion and forming one of the following volcanic edifices; tuff cones, tuff rings and maars.

Tuff cones and tuff rings form by shallow explosions and tend to have finer grained deposits with better sorting than maars which are formed by deeper more powerful eruptions.

Deposits of Phreatomagmatic Eruptions

Well developed beds ranging in thickness from a few millimeters to several tens of centimeters.

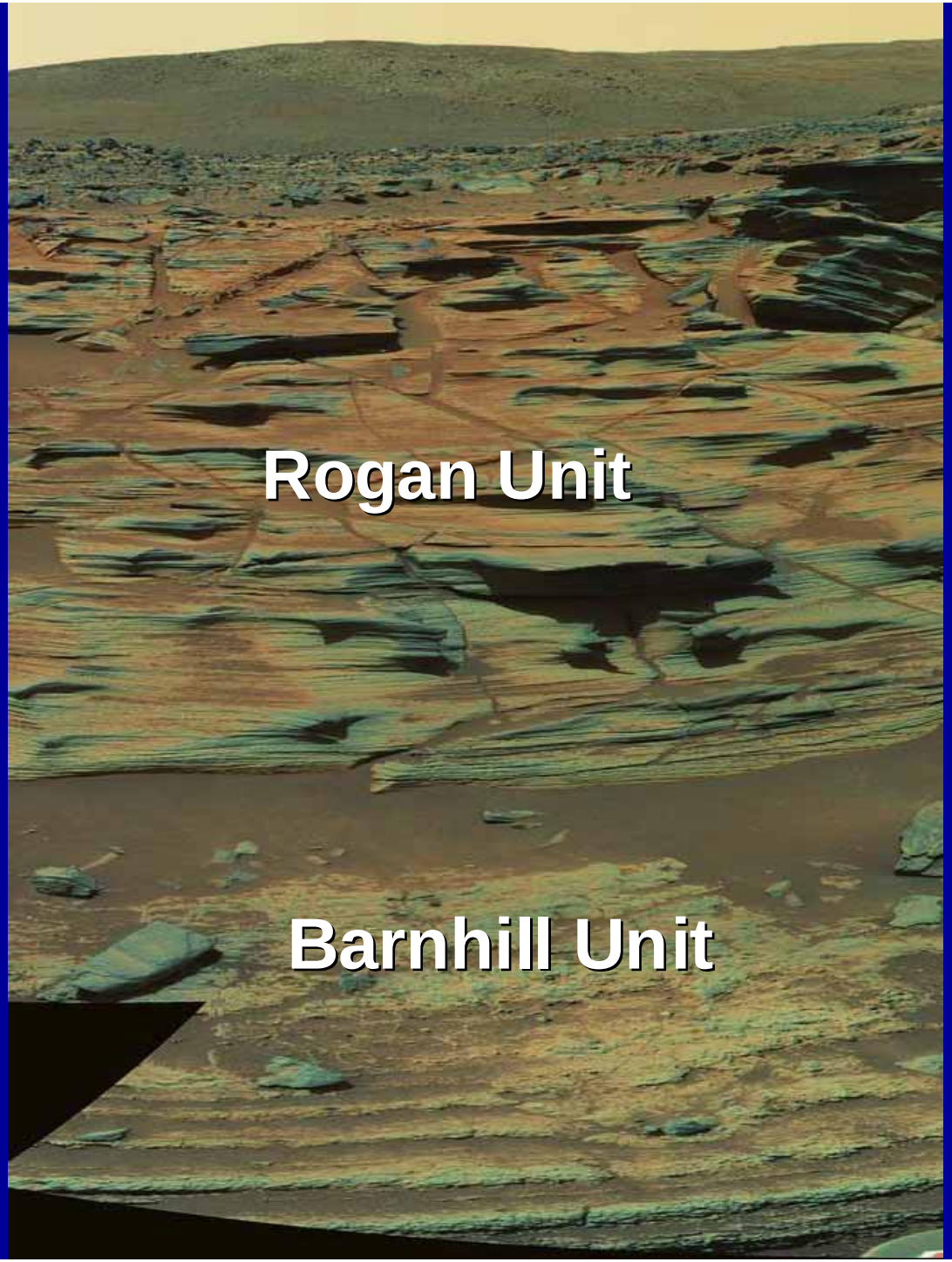
Profusion of numerous thin beds is result of a large number of short eruptive pulses.

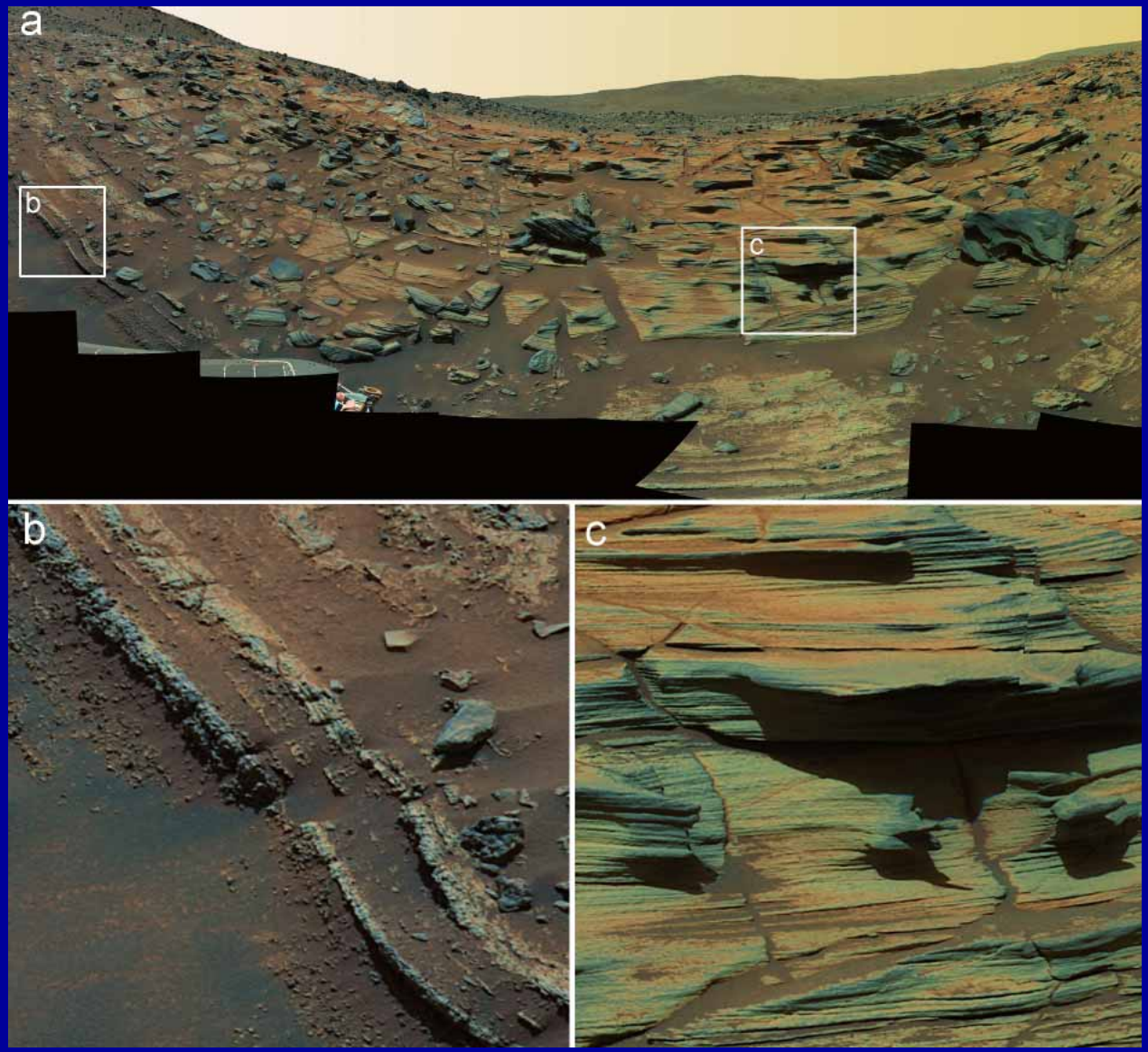
Bedding varies from plane parallel to crossbedded.

Lapilli and bomb sags are commonly associated with phreatomagmatic deposits

Home Plate

Roughly circular shaped, layered, plateau structure ~3 m high and 90 m diameter. Composed of two main units (Barnhill and Rogan) with inward dipping beds and capped with basaltic rocks.


Rogan Unit
Barnhill Unit

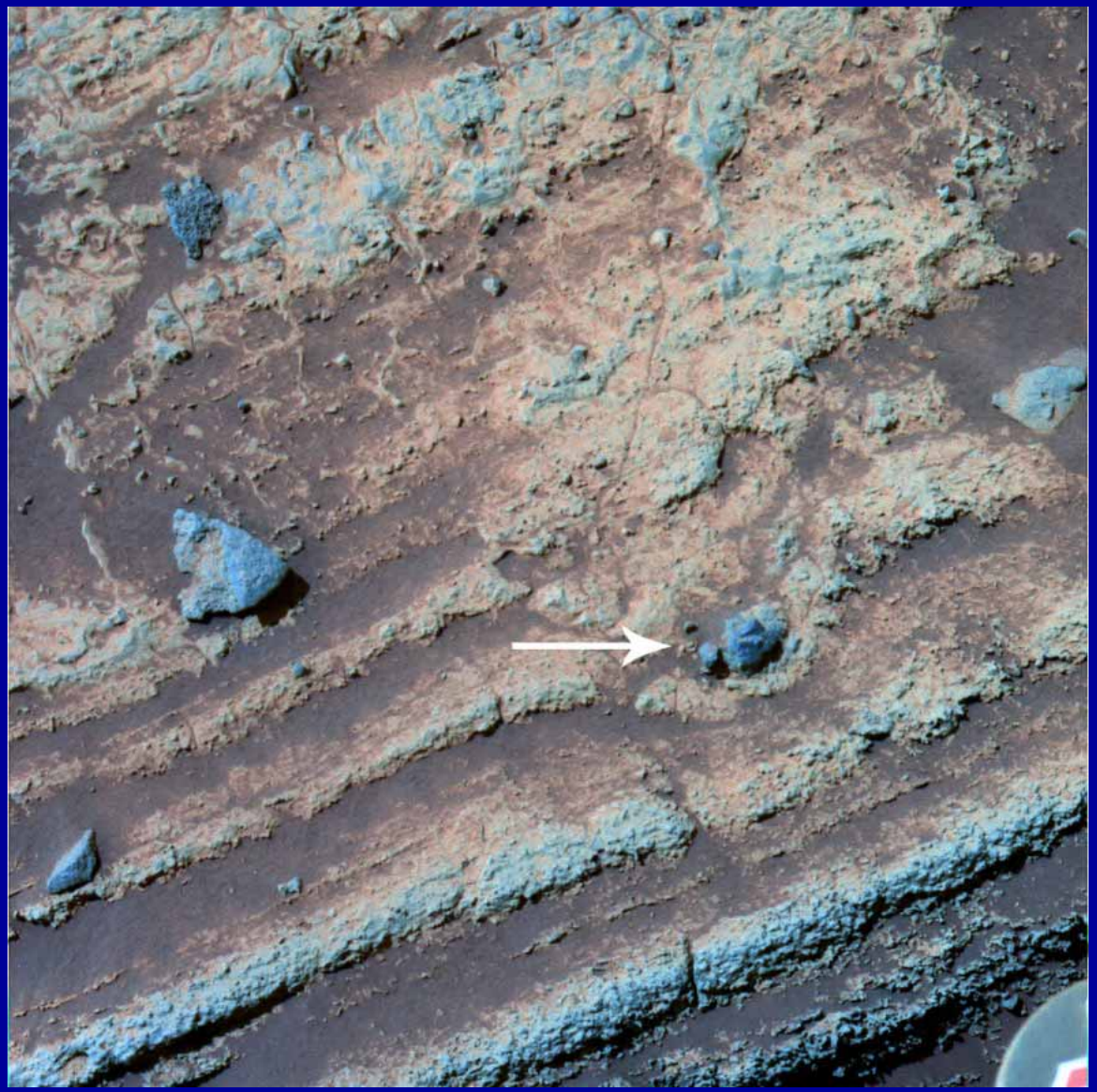

a
b
c
b
c

Barnhill Unit

Lower most unit with alternating coarse and fine parallel layers

Bomb sag

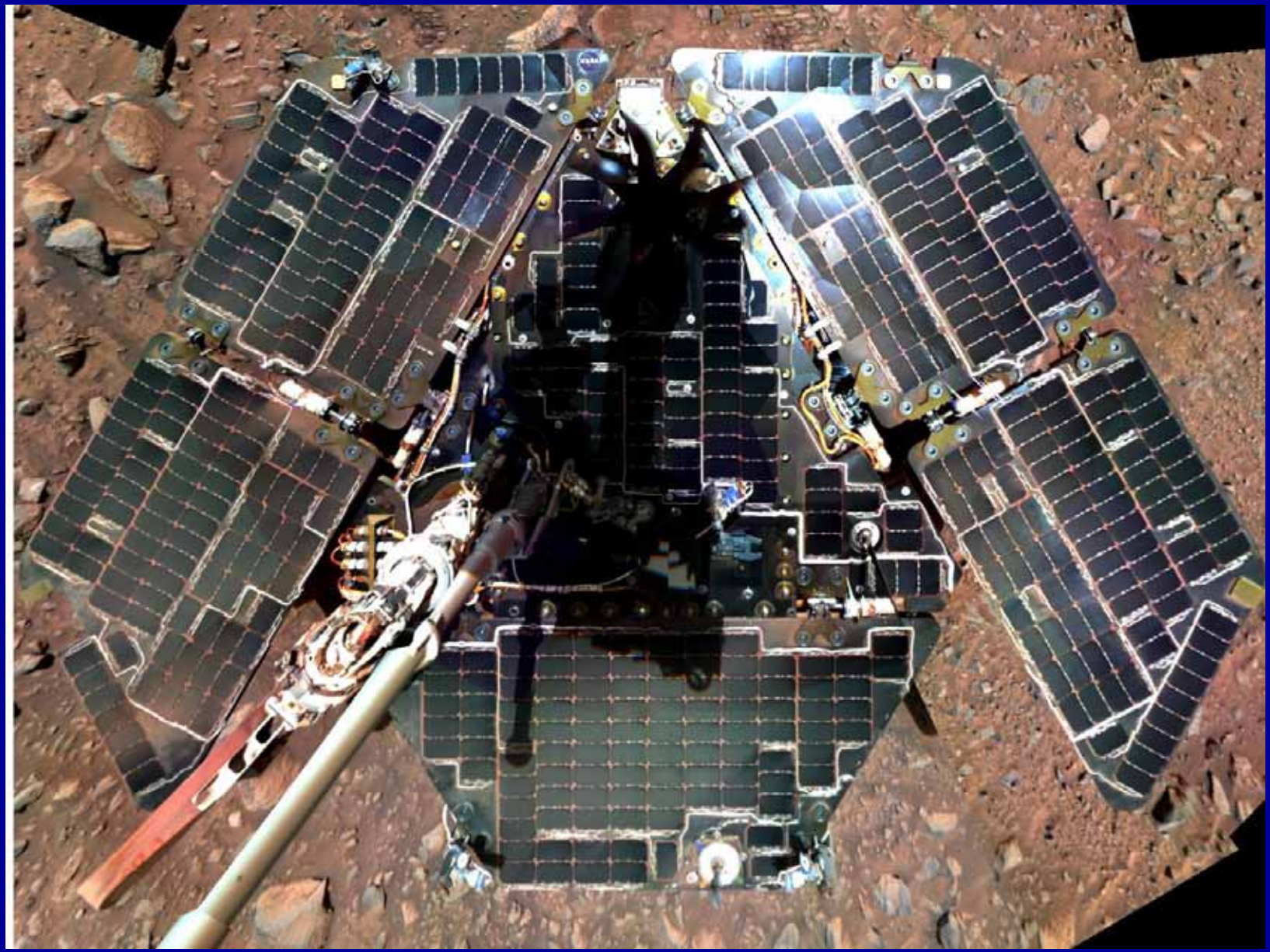
Subrounded to rounded grains (accretionary lapilli) 0.5 to 3mm

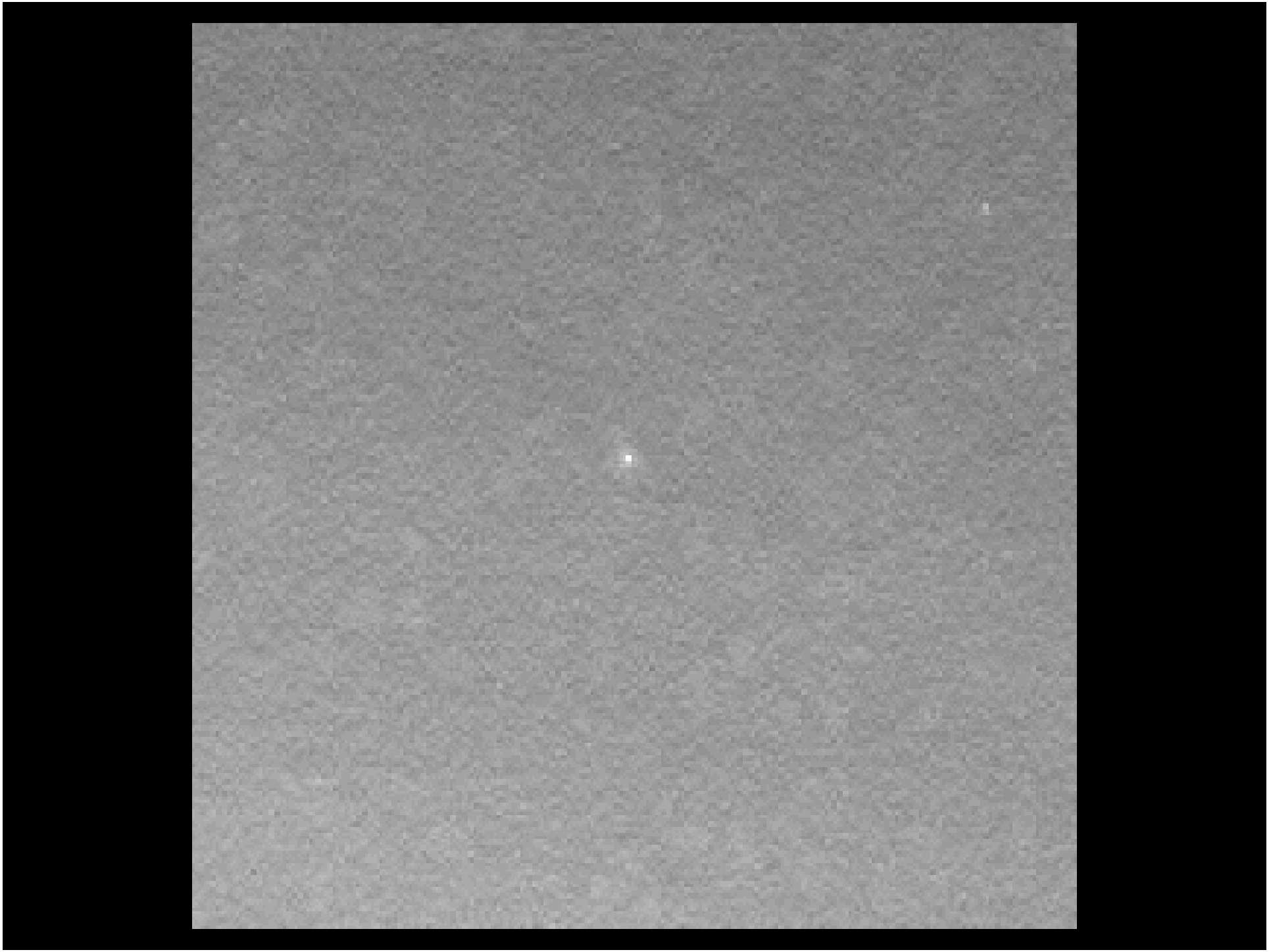


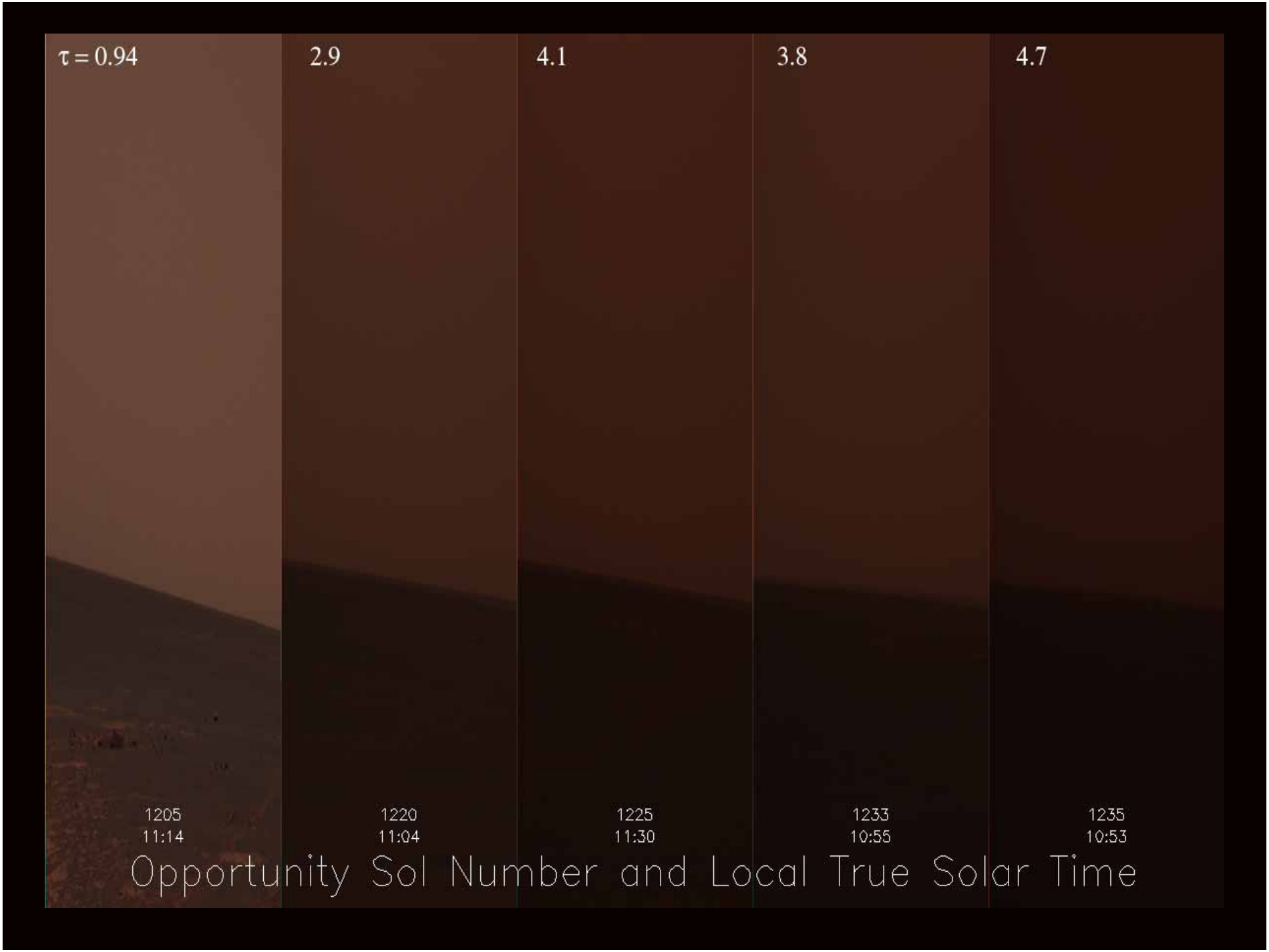
Bomb sags characteristic of hydrovolcanic deposits. Amount of water necessary for soft sediment deformation in fine-grained sediment is about 15-20% (Heiken, 1971)

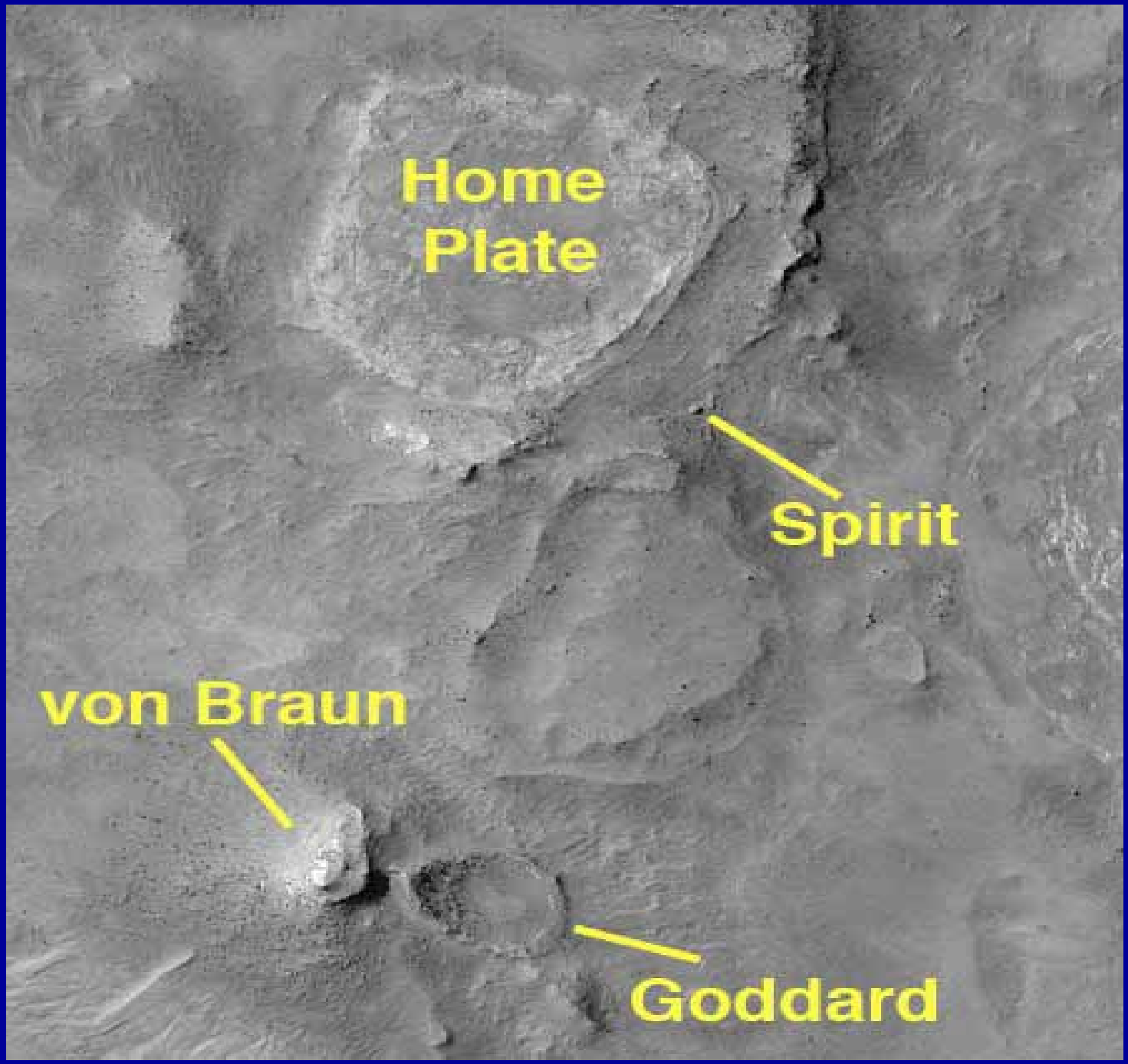
Spirit Was Dirty Until…

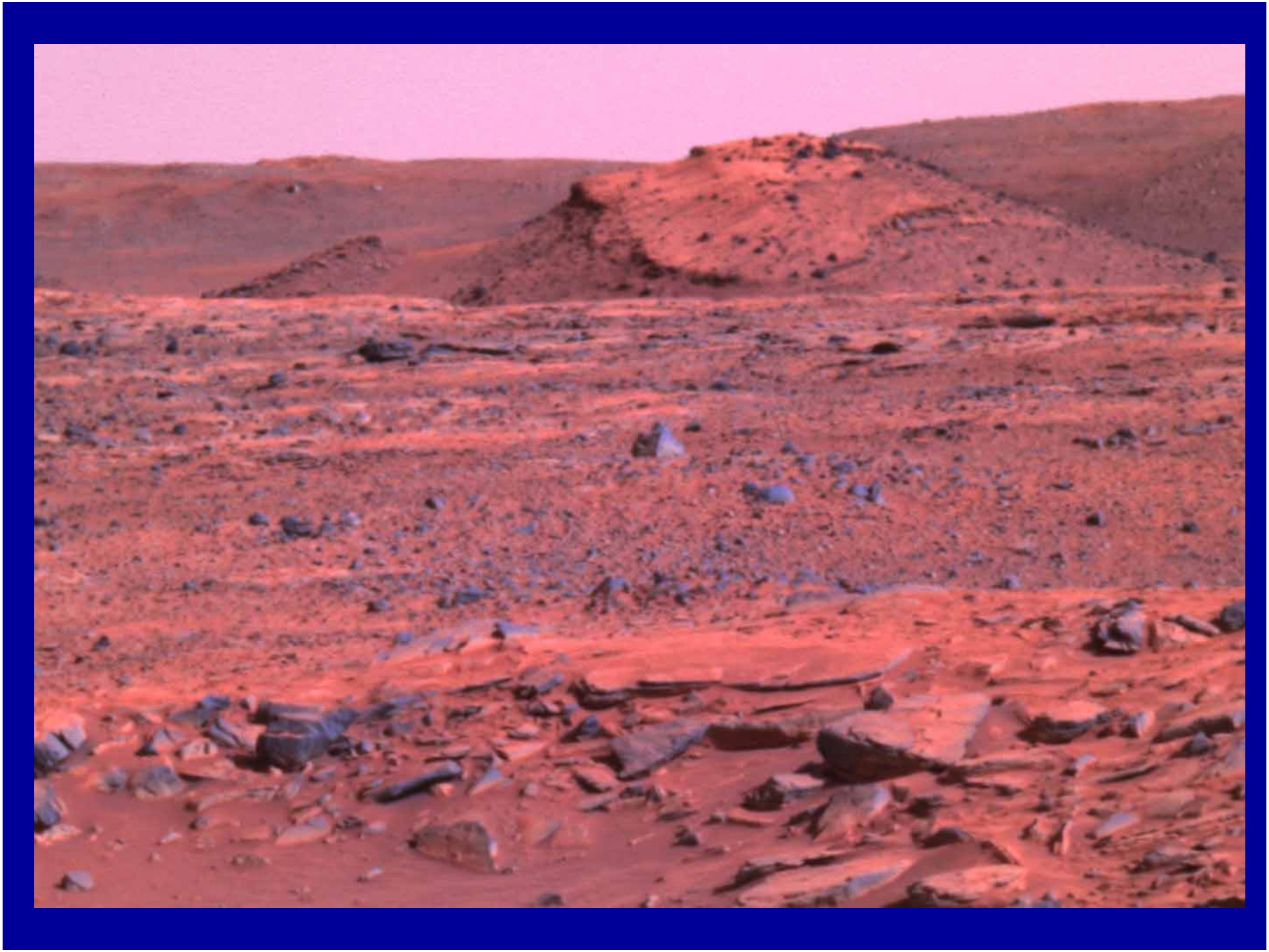
A Miracle Occurred

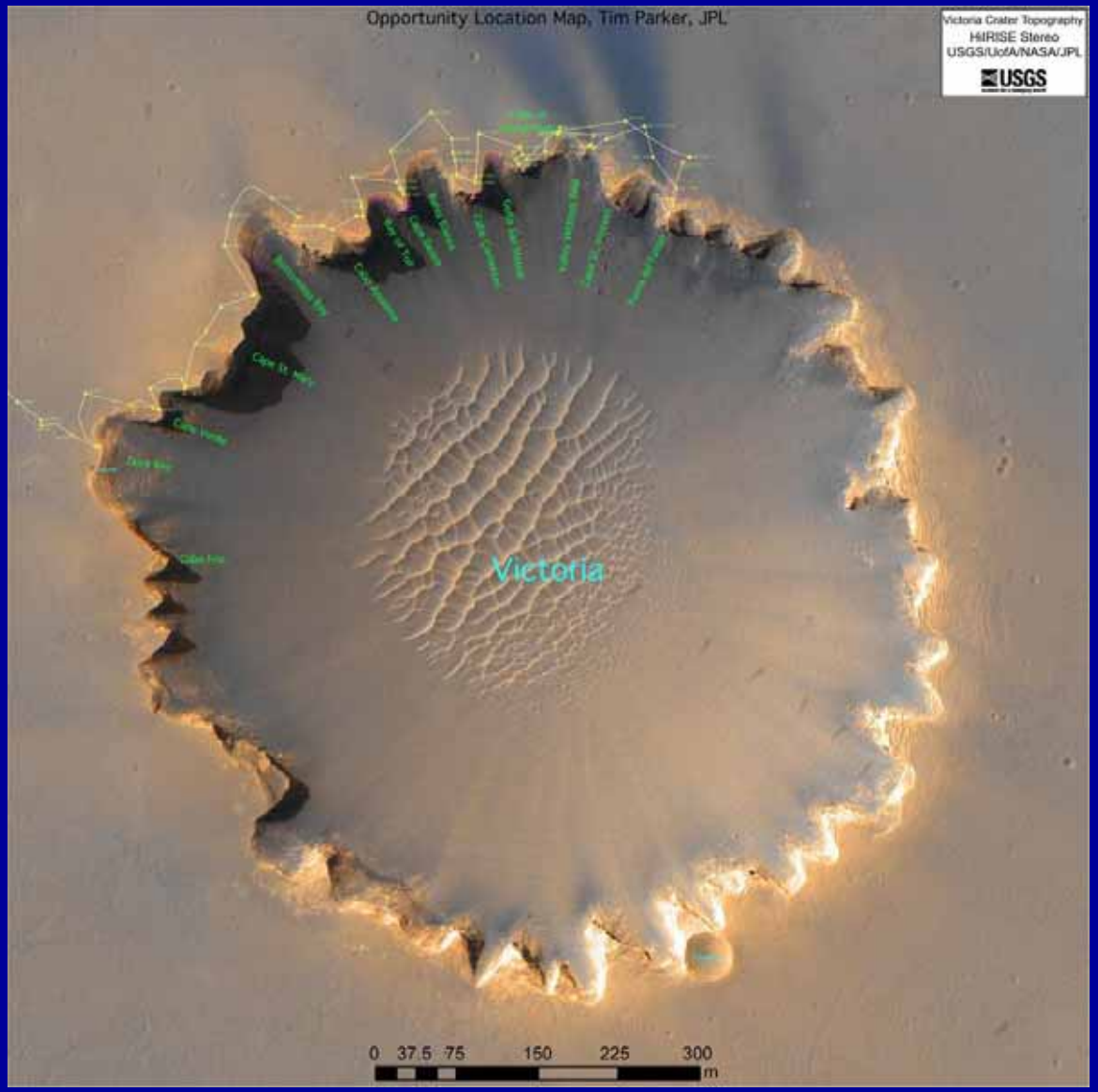


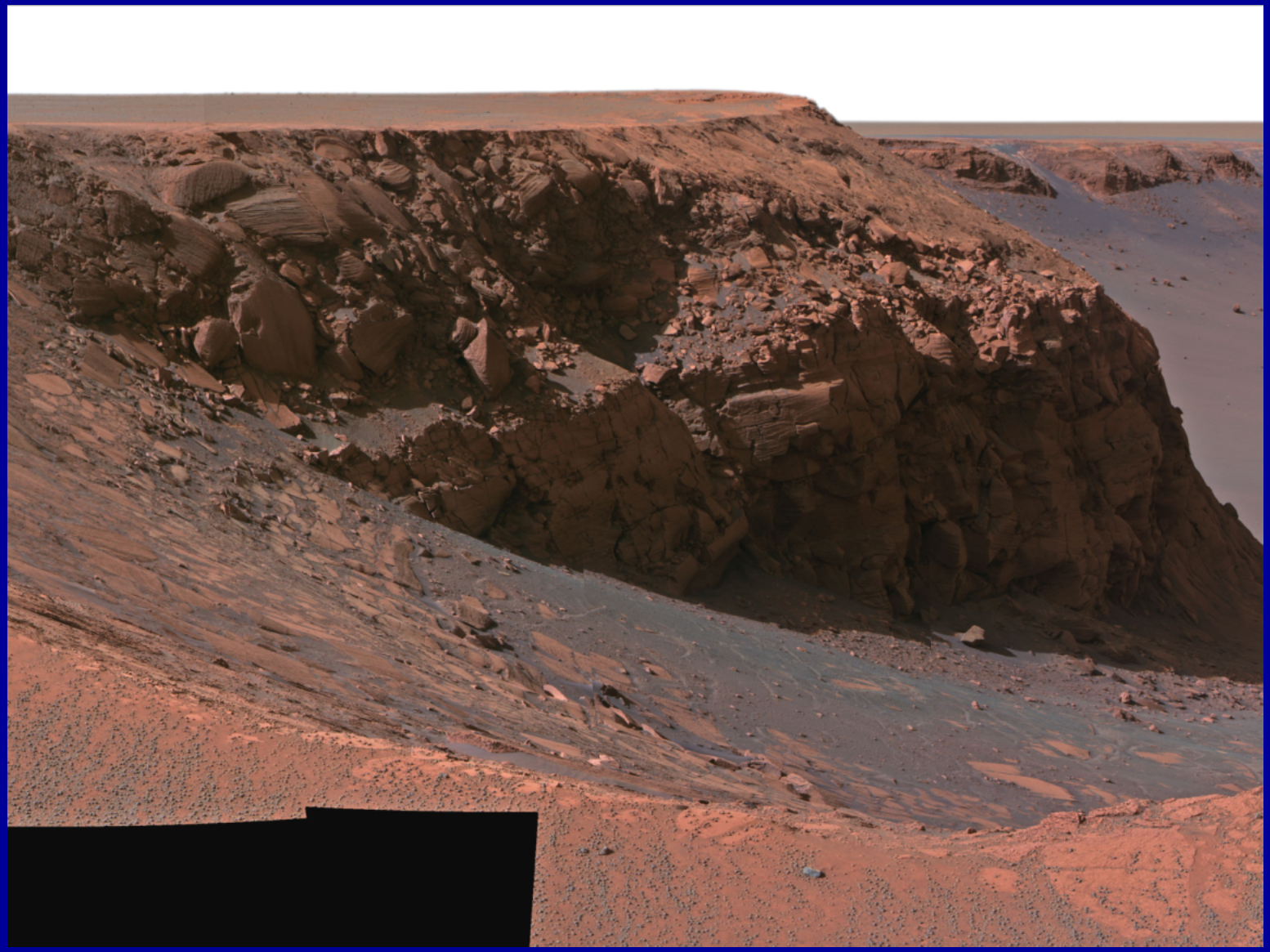


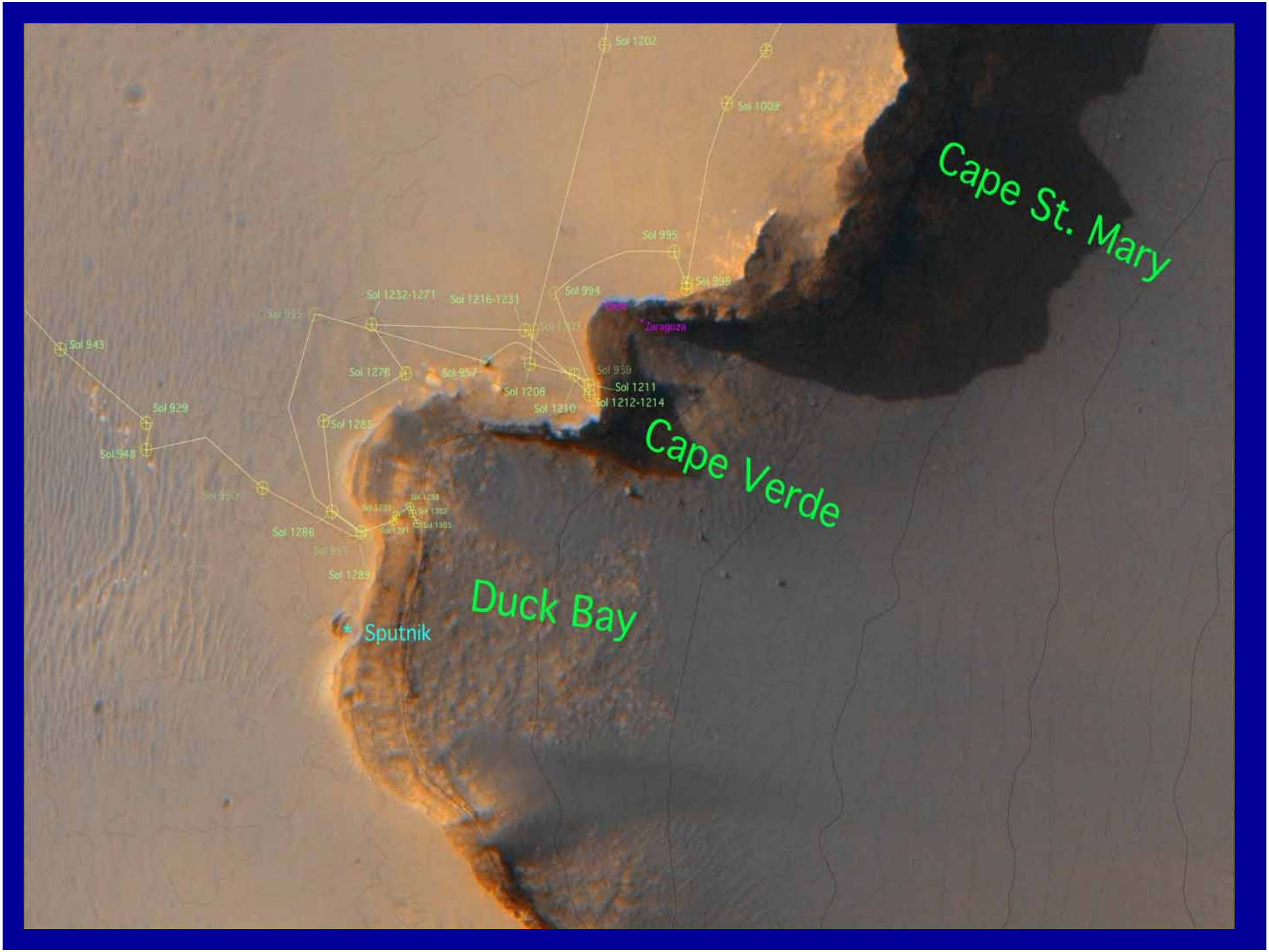

τ = 0.94
2.9
4.1
3.8
4.7
1205
11:14
1220
11:04
1225
11:30
1233
10:55
1235
10:53
Opportunity Sol Number and Local True Solar Time


Home
Plate
Spirit
von Braun
Goddard




Opportunity Location Map, Tim Parker, JPL
Victoria Crater Topography
HiRISE Stereo
USGS/UofA/NASA/JPL
USGS
Victoria
0 37.5 75 150 225 300
m




Sol 1202
Sol 1009
Cape St. Mary
Sol 995
Sol 999
Sol 994
Sol 1232-1271
Sol 1216-1231
Sol 935
Zaragoza
Sol 943
Sol 1278
Sol 957
Sol 959
Sol 1211
Sol 1208
Sol 1212-1214
Sol 1210
Sol 929
Sol 1285
Cape Verde
Sol 948
Sol 1286
Sol 1289
Duck Bay
Sputnik

And as the Sun Sinks Slowly in the West . . .