



***“Mars: An Earthly Obsession”***

***Calvin H. Seaman / NASA***

***November 1, 2012***

# Mars Astronomers

Mars has been the subject of scientific interest and intense study for centuries.

Anasazi

Mayans

Incas

Roman (Mars)

Greek (Ares)

Ptolemy

Copernicus

Kepler

Galileo

Newton



Stonehenge

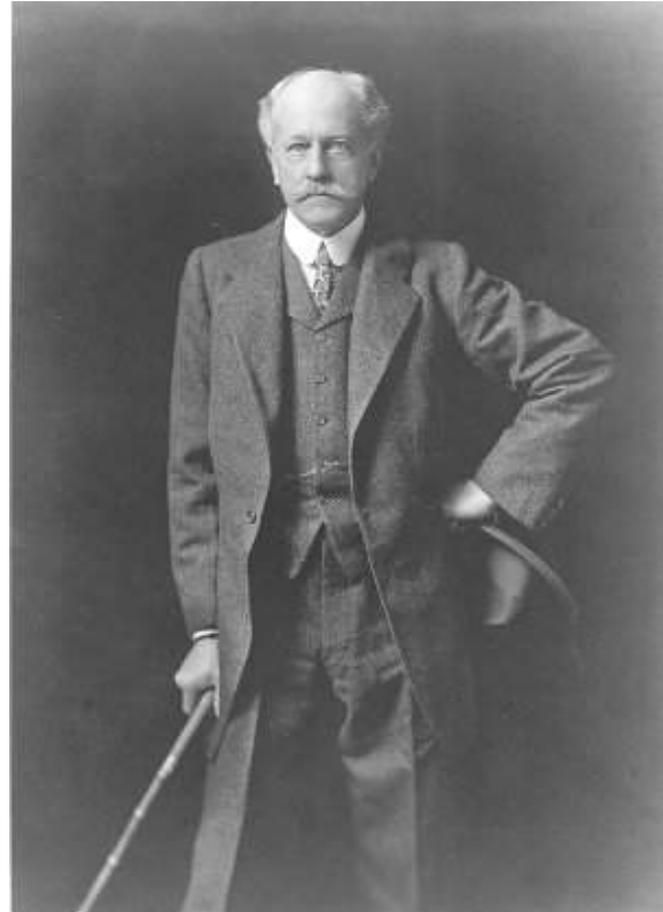


Chichén Itzá

# Giovanni Schiaparelli and Percival Lowell



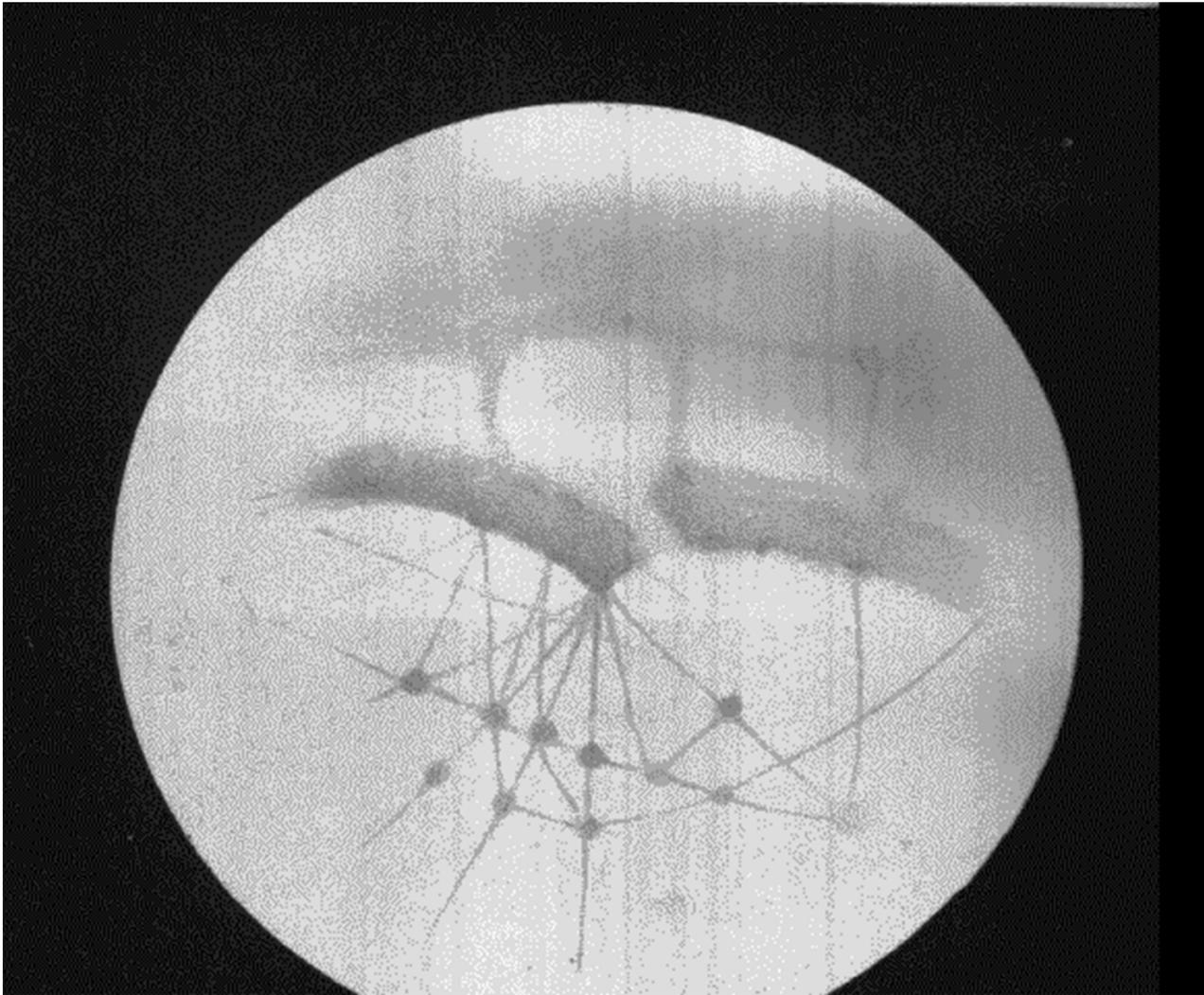
Giovanni Schiaparelli



Percival Lowell

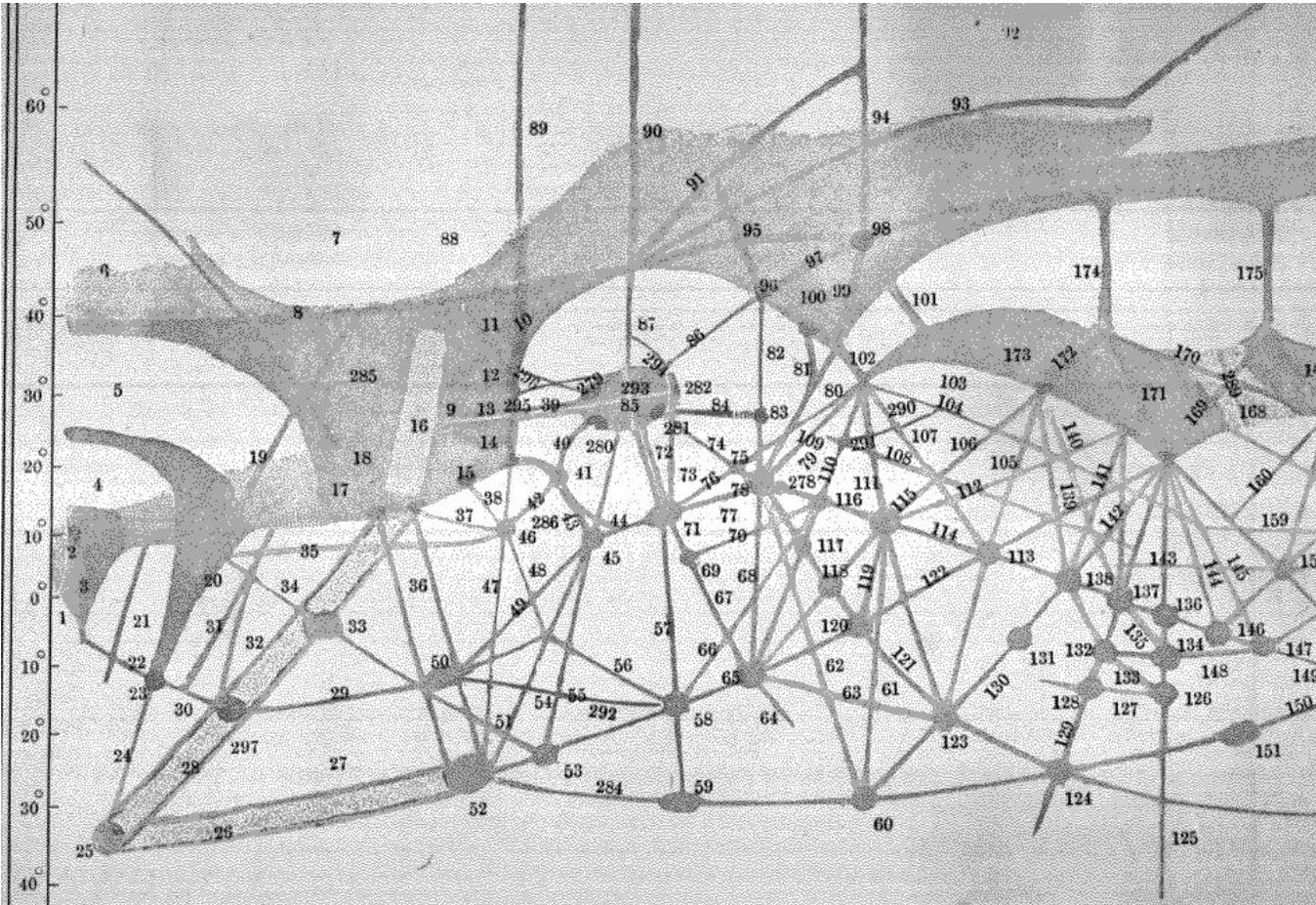
1850's to Early 1900's

## *Canali* vs. “Canals”



- Oceans
- Deserts
- Forests
- Oases
- Pumping Stations
- Locks/Dikes
- Cities
- Intelligent Beings
- Government!

# *Canali* vs. “Canals”



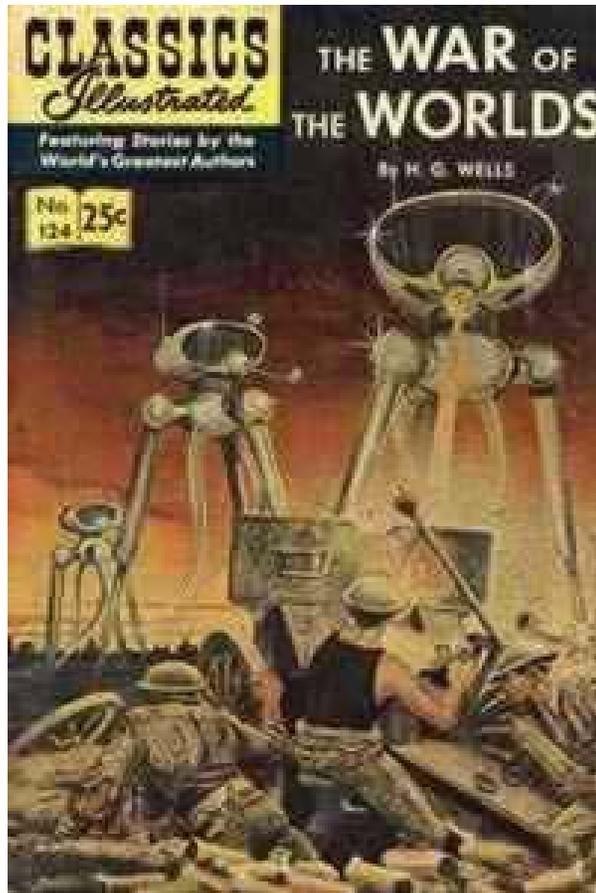
- Oceans
- Deserts
- Forests
- Oases
- Pumping Stations
- Locks/Dikes
- Cities
- Intelligent Beings
- Government!

## H. G. Wells and Orson Welles

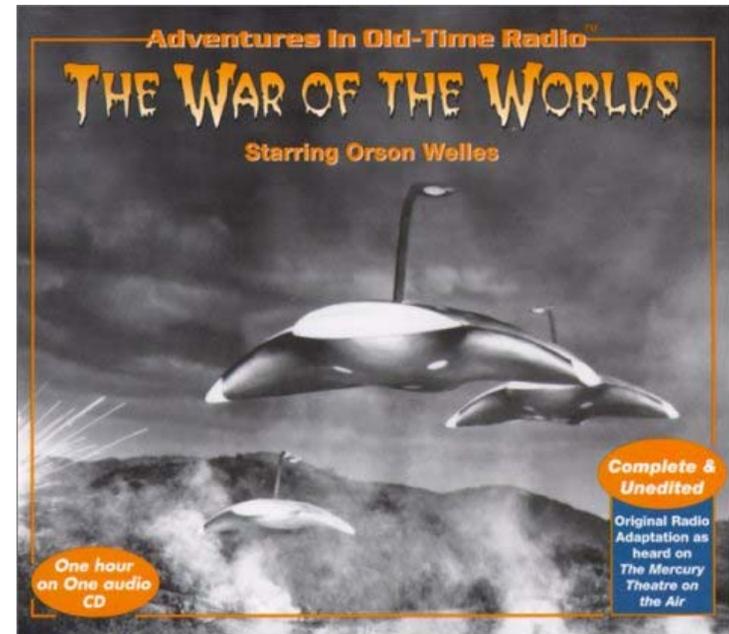


# **“The War of the Worlds”**

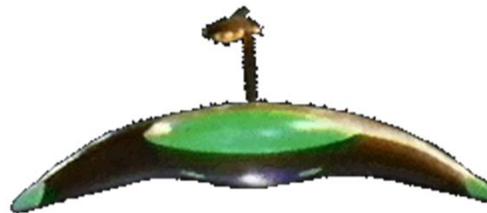
**October 30, 1938**



**Written: 1898**



**Grover's Mill,  
New Jersey**



# Marvin the Martian



# My Favorite Martian



JACK  
NICHOLSON

GLENN  
CLOSE

ANNETTE  
BENING

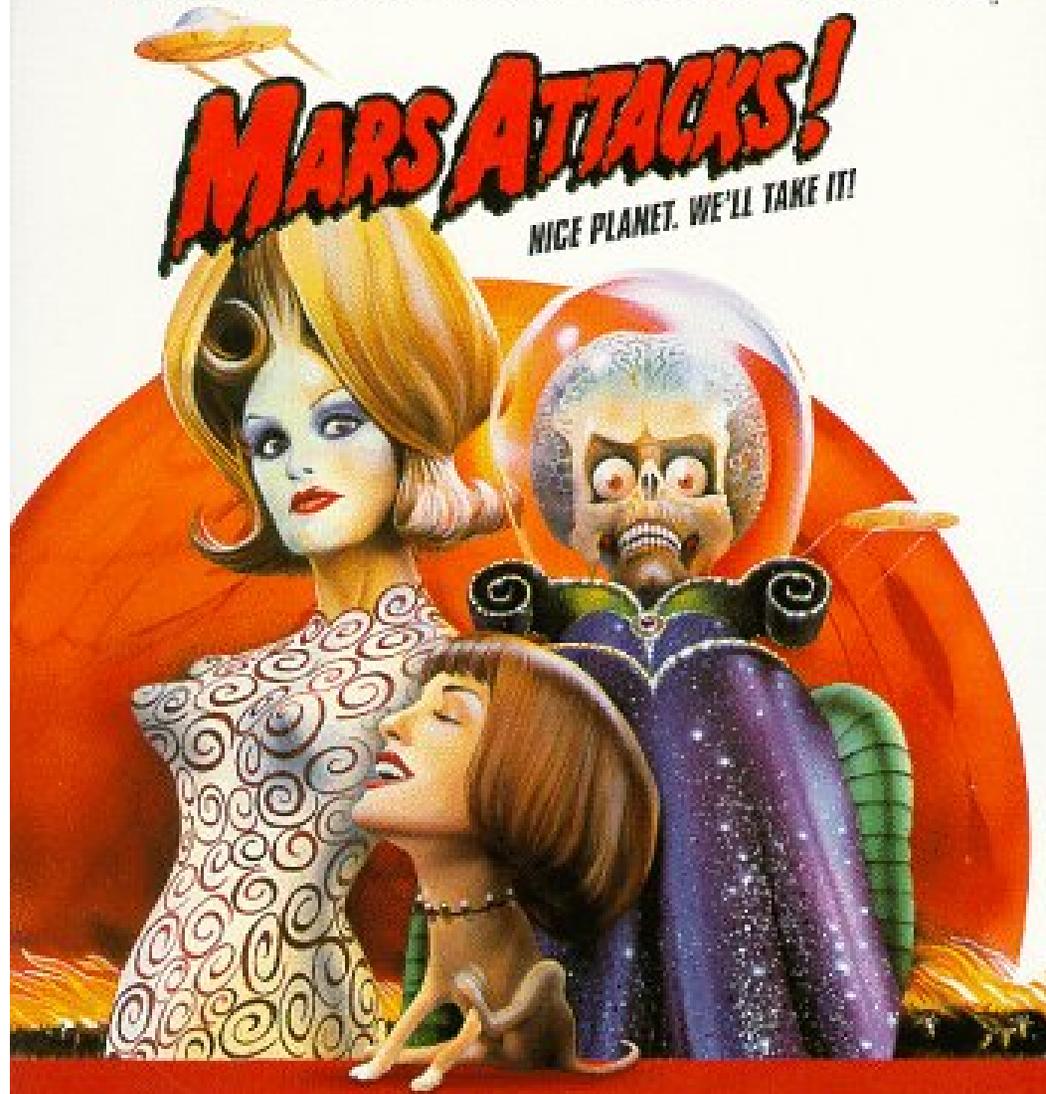
PIERCE  
BROSNAN

DANNY  
DEVITO

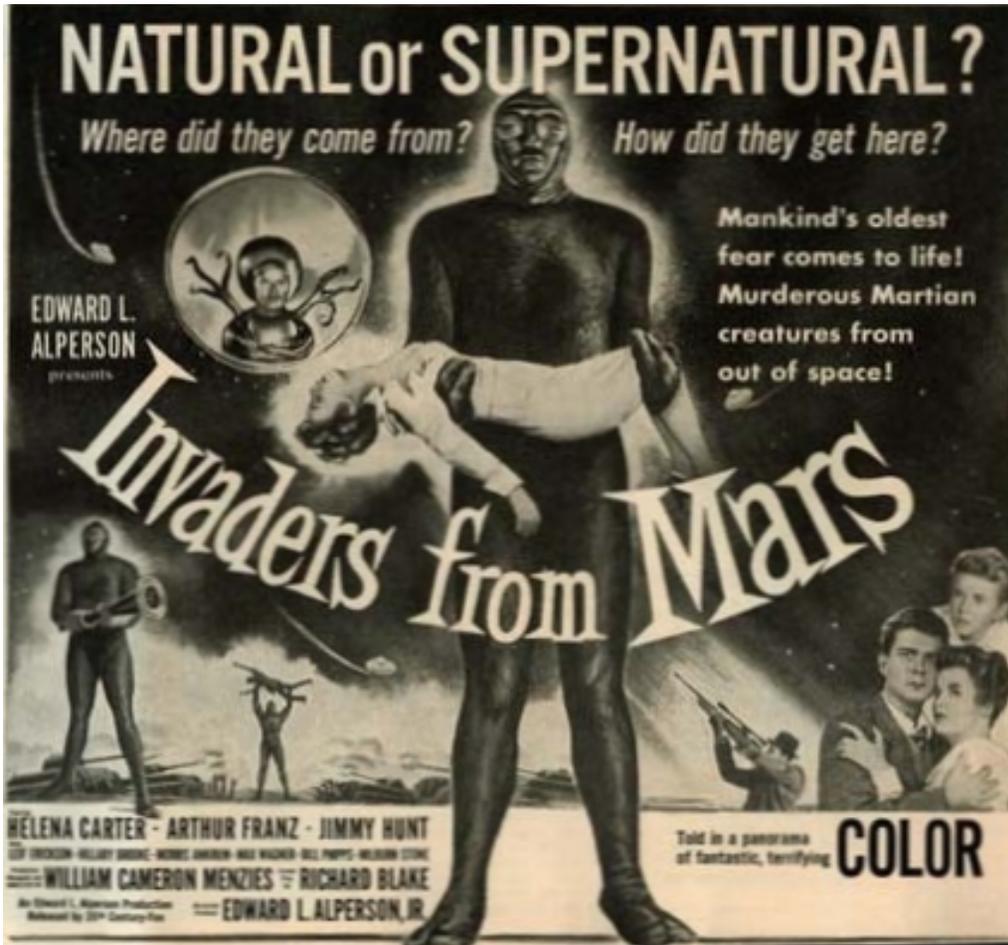
DVD

# MARS ATTACKS!

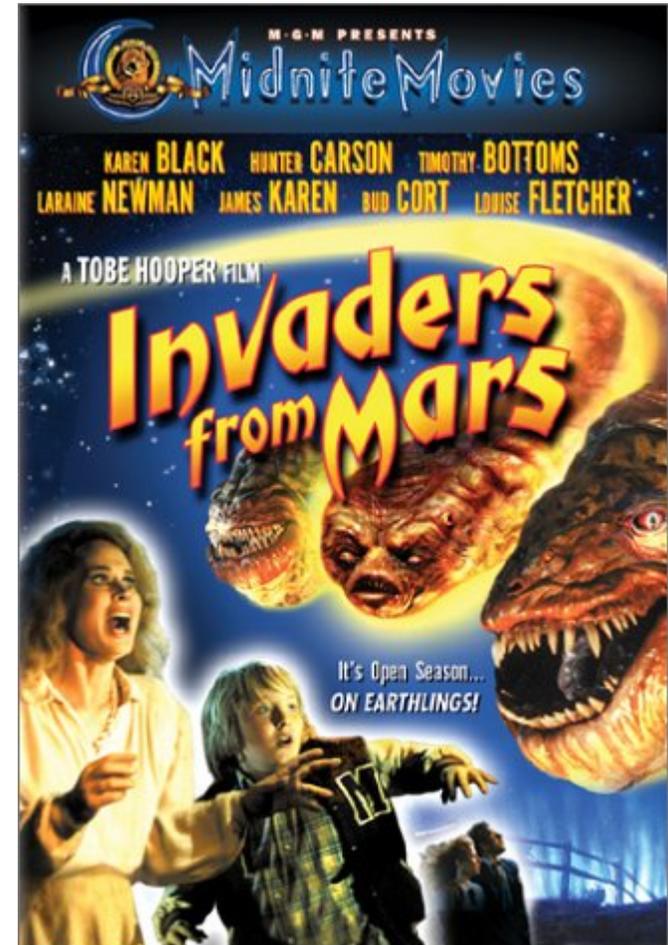
NICE PLANET. WE'LL TAKE IT!



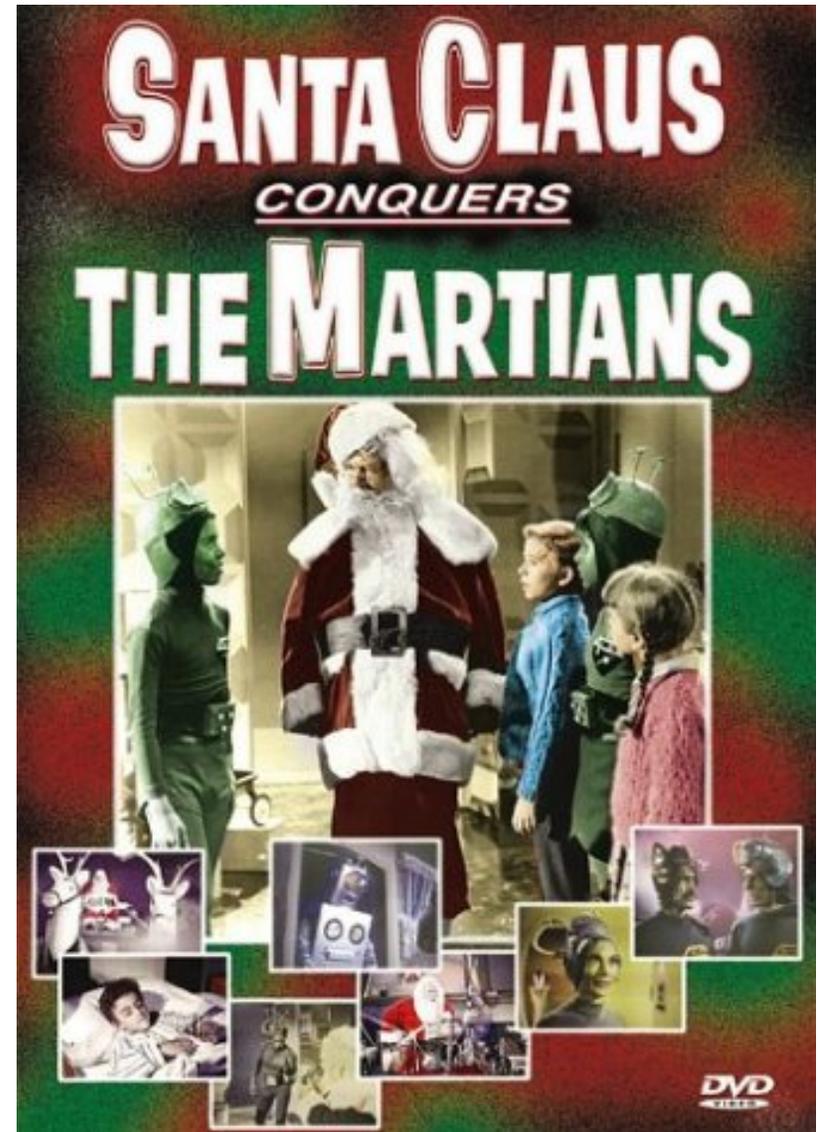
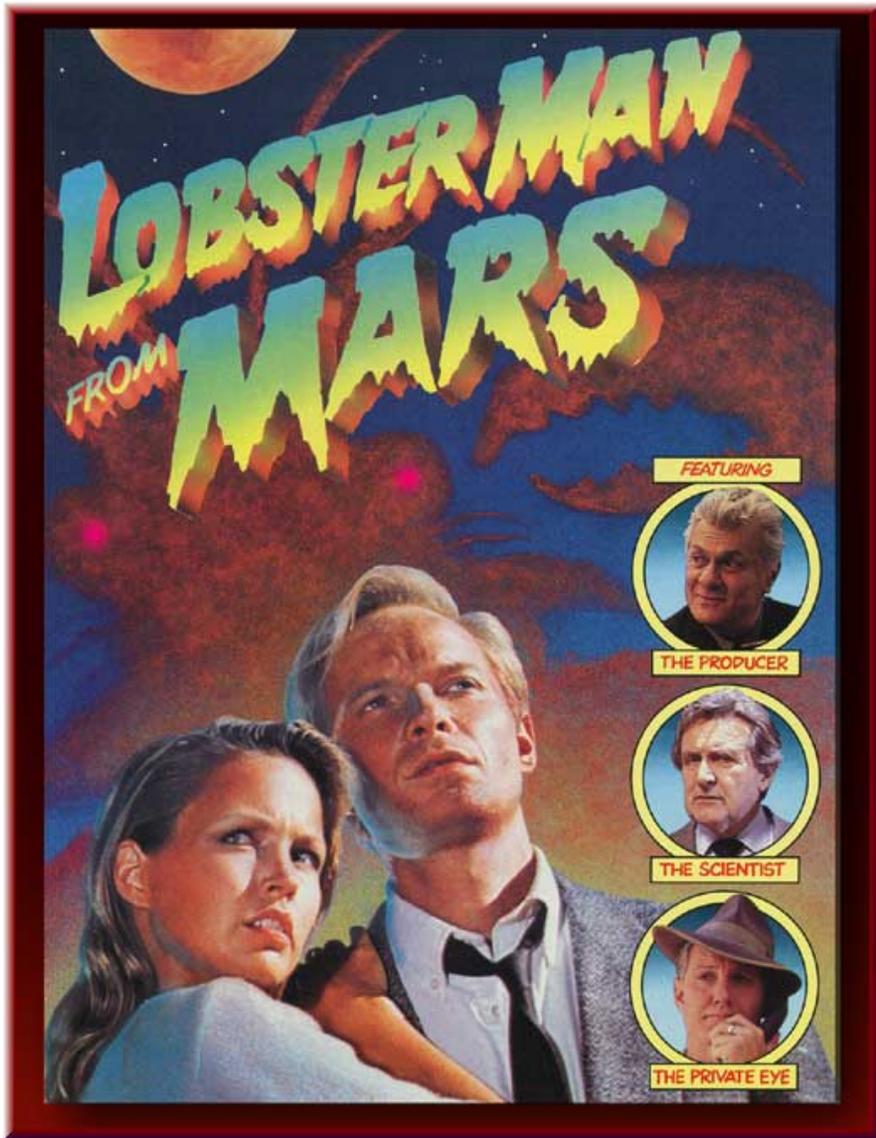
# Invaders From Mars -- Twice!!



1953



1986



# “Mars Faces”



**Cydonia Region**



**Galle Crater**

# From Mars, With Love

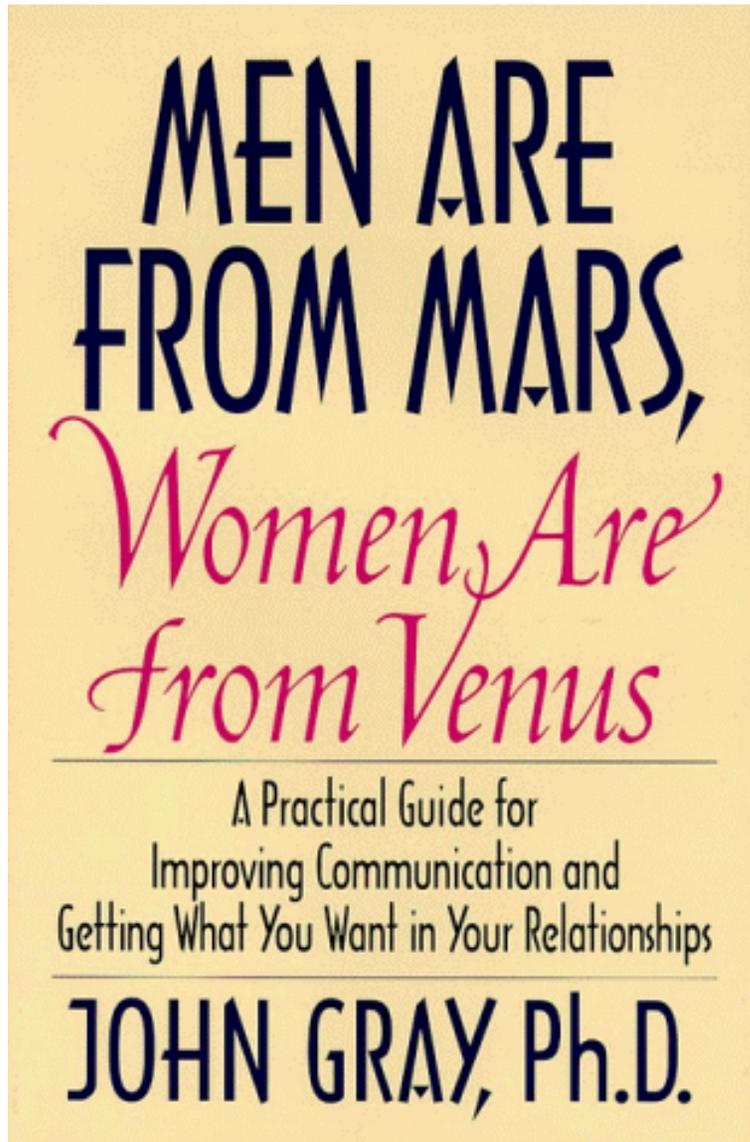


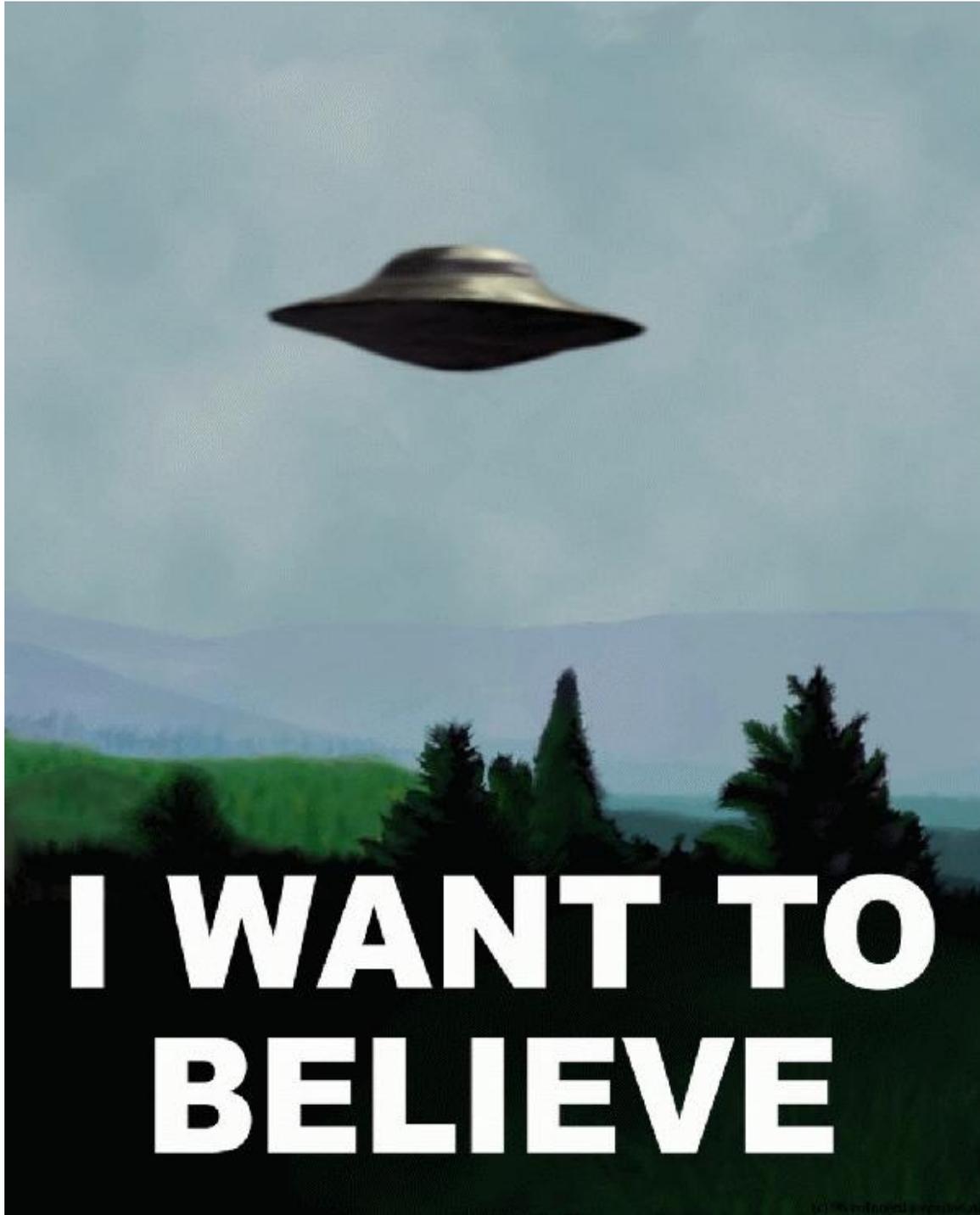
**Alba Patera**



**Promethei Rupes Region**

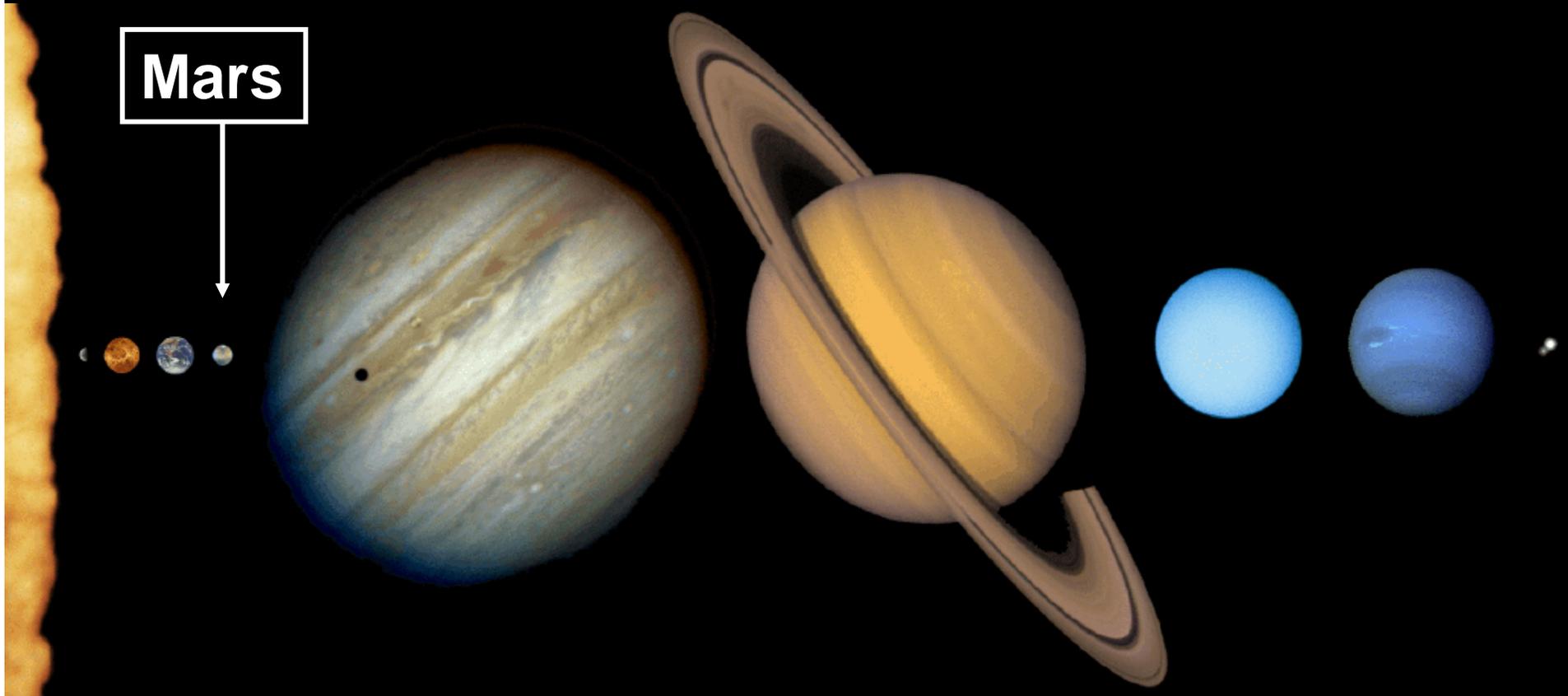
# Men Are From Mars?!



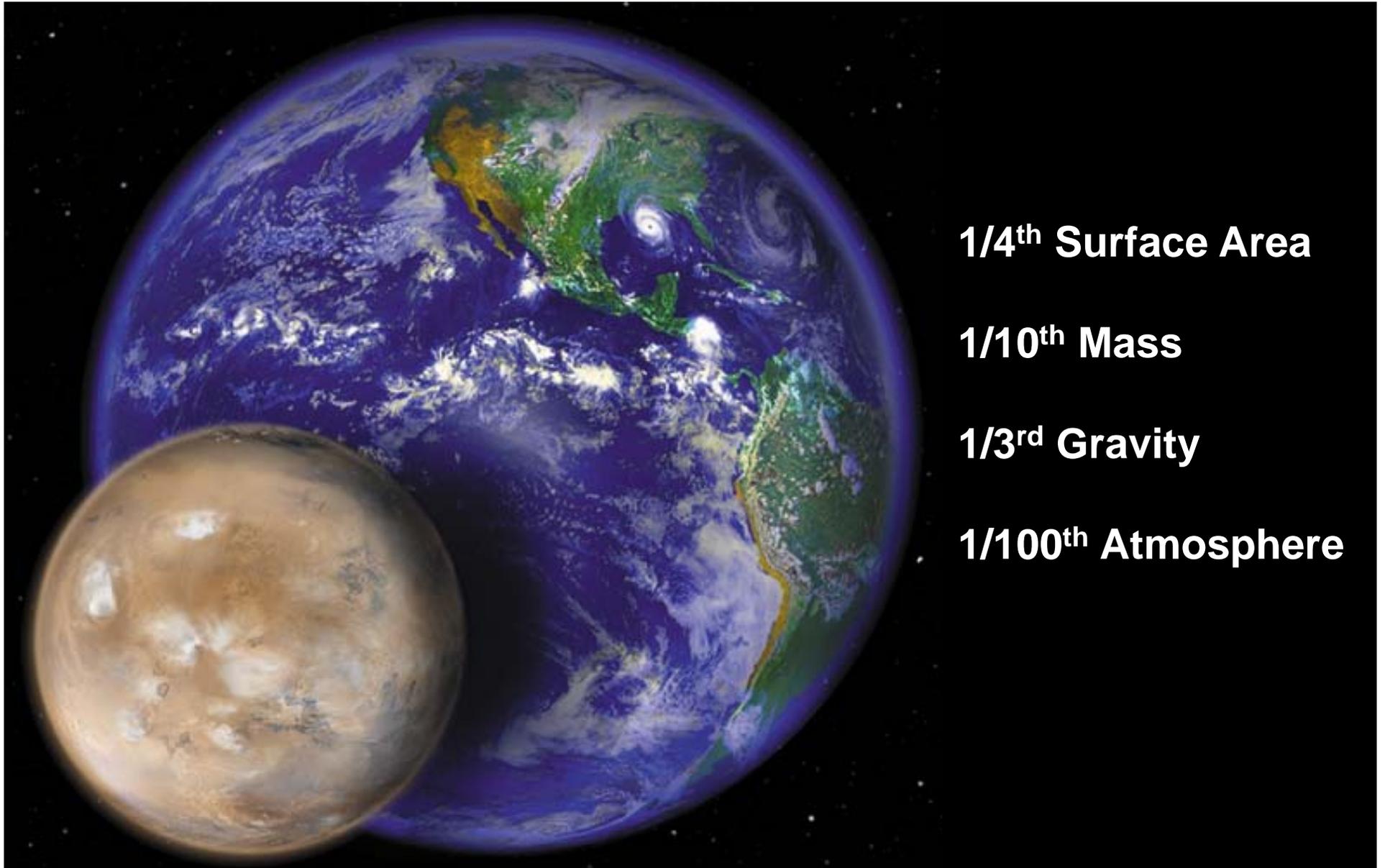


**I WANT TO  
BELIEVE**

Mars



# Earth-Mars Comparison



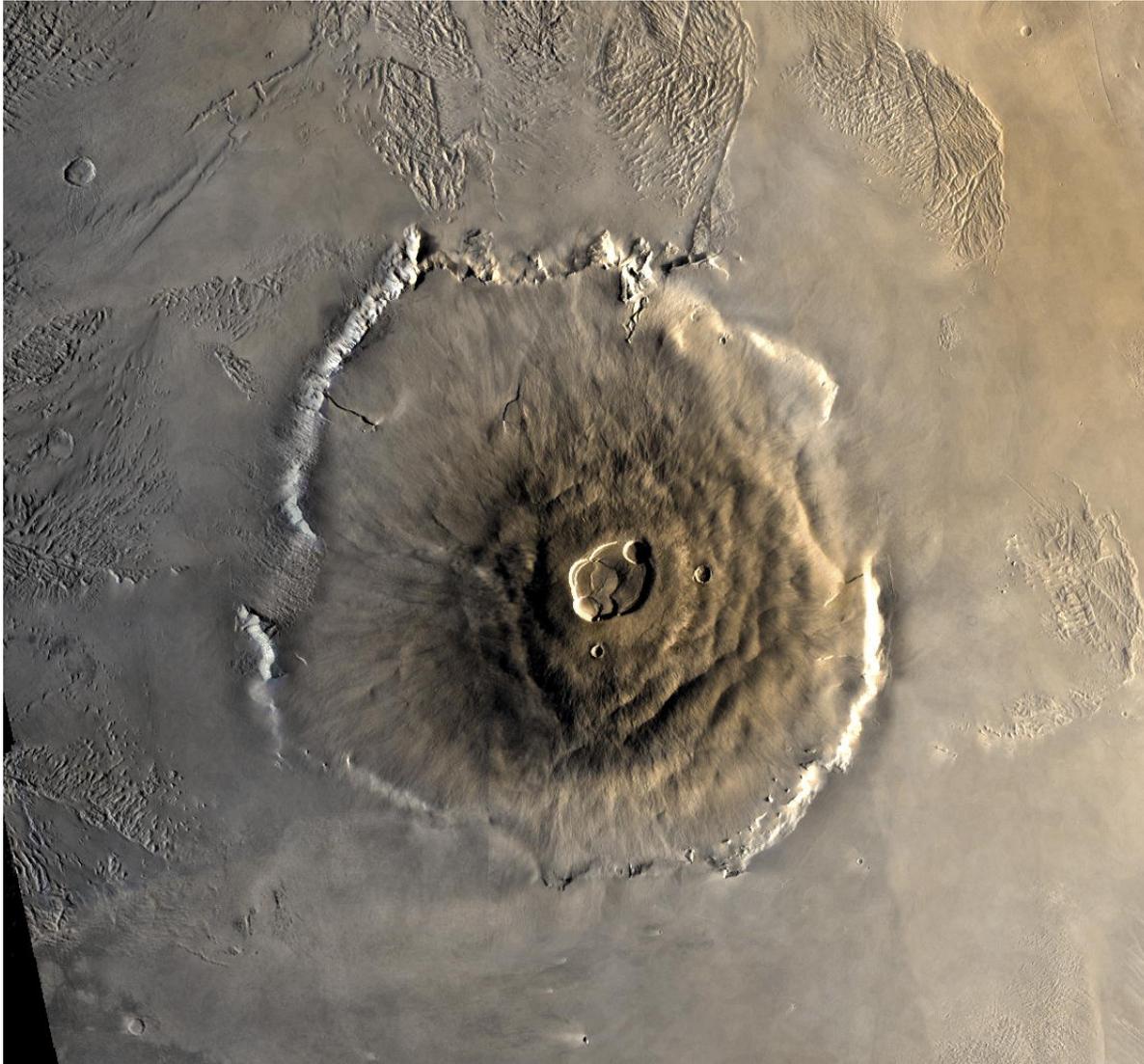
**1/4<sup>th</sup> Surface Area**

**1/10<sup>th</sup> Mass**

**1/3<sup>rd</sup> Gravity**

**1/100<sup>th</sup> Atmosphere**

# Olympus Mons



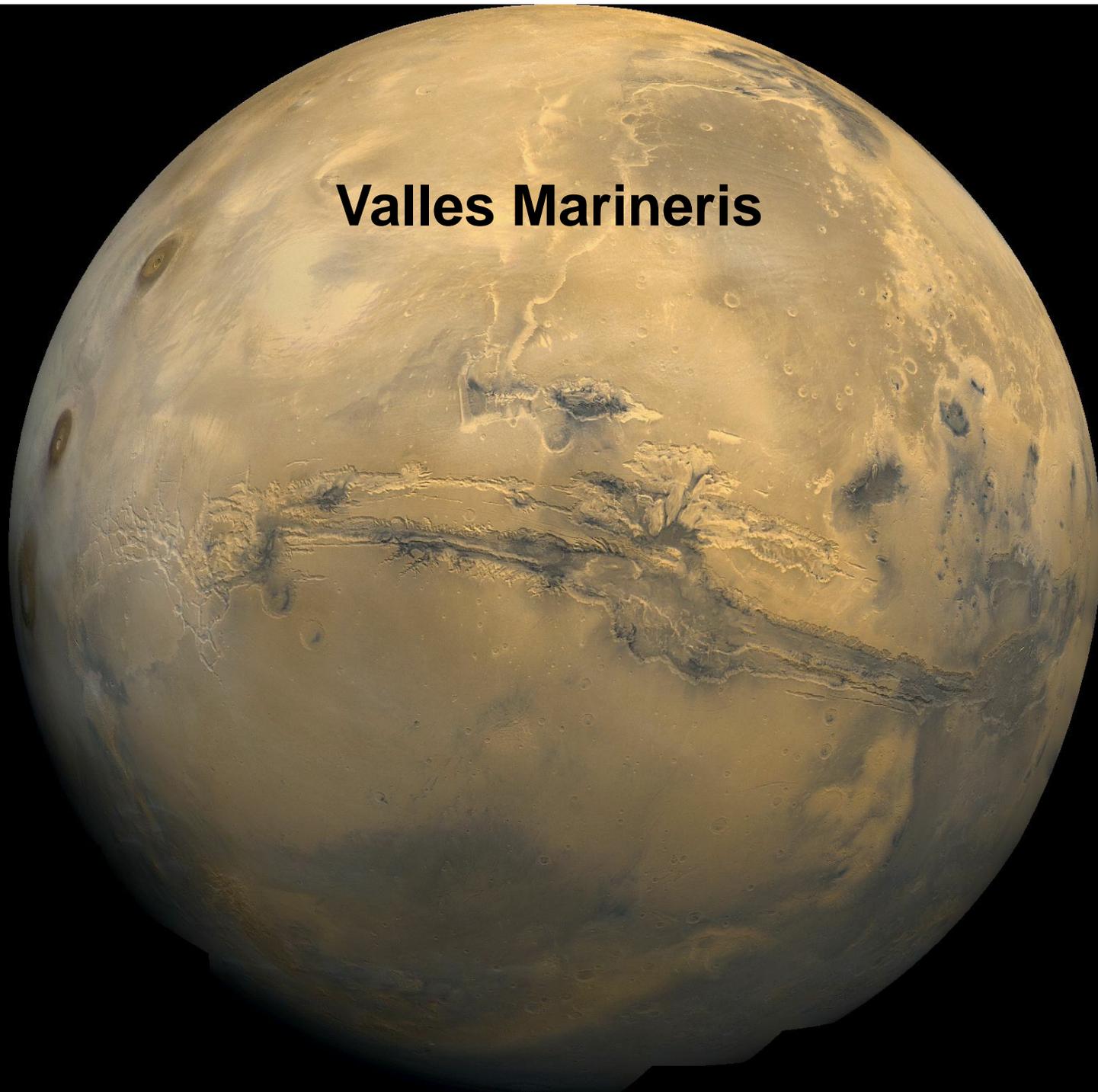
**17 Miles High**

**375 Miles Diameter**

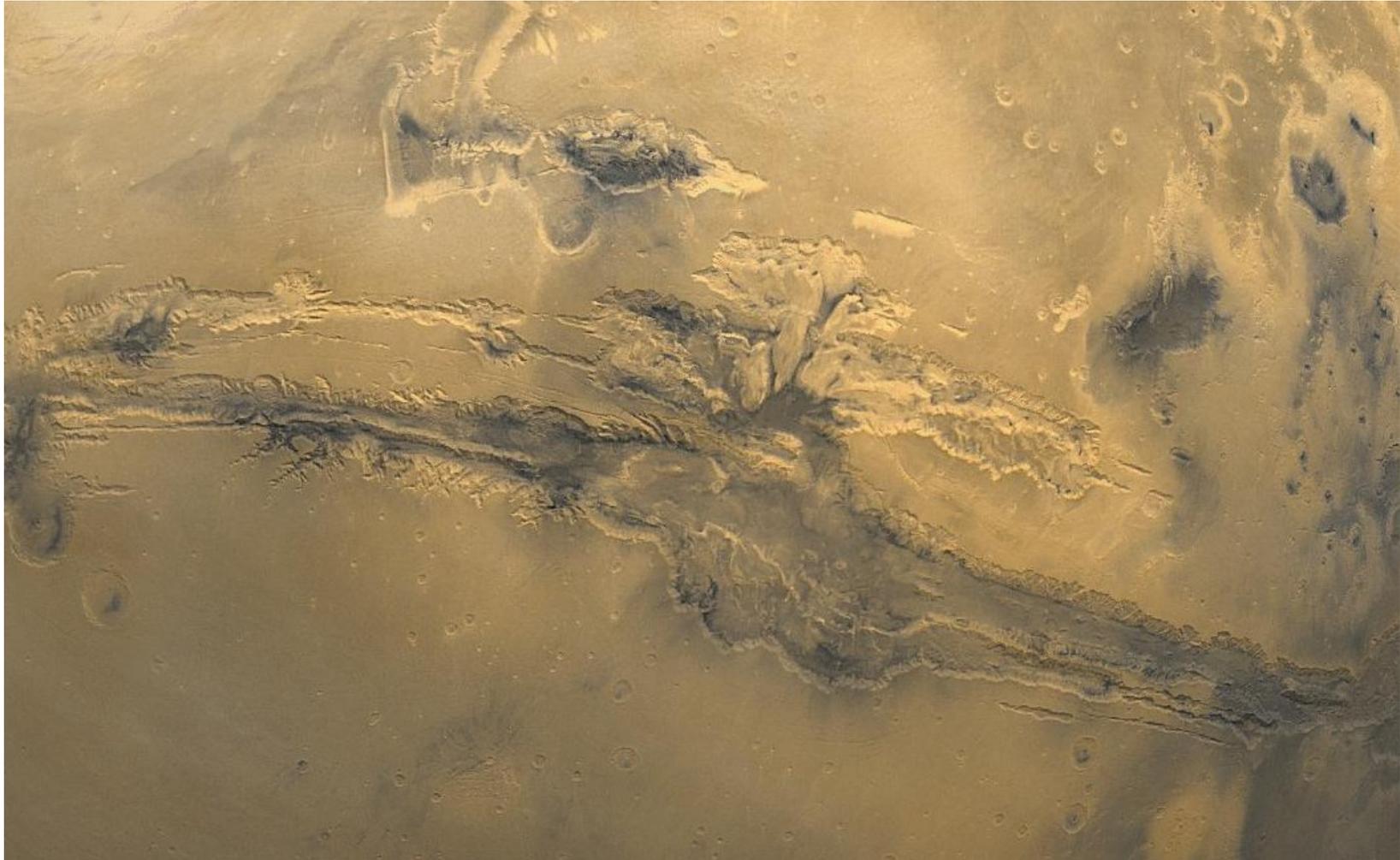
**Tallest Volcano  
In the Solar System!**

**(Mt Everest is only  
5 Miles high)**

# Valles Marineris



# Valles Marineris



**2500 Miles long  
5 miles deep!**

**(Grand Canyon: Only 277 Miles  
long and 5000 feet deep)**

# Valles Marineris would span the USA!



# Water on Mars



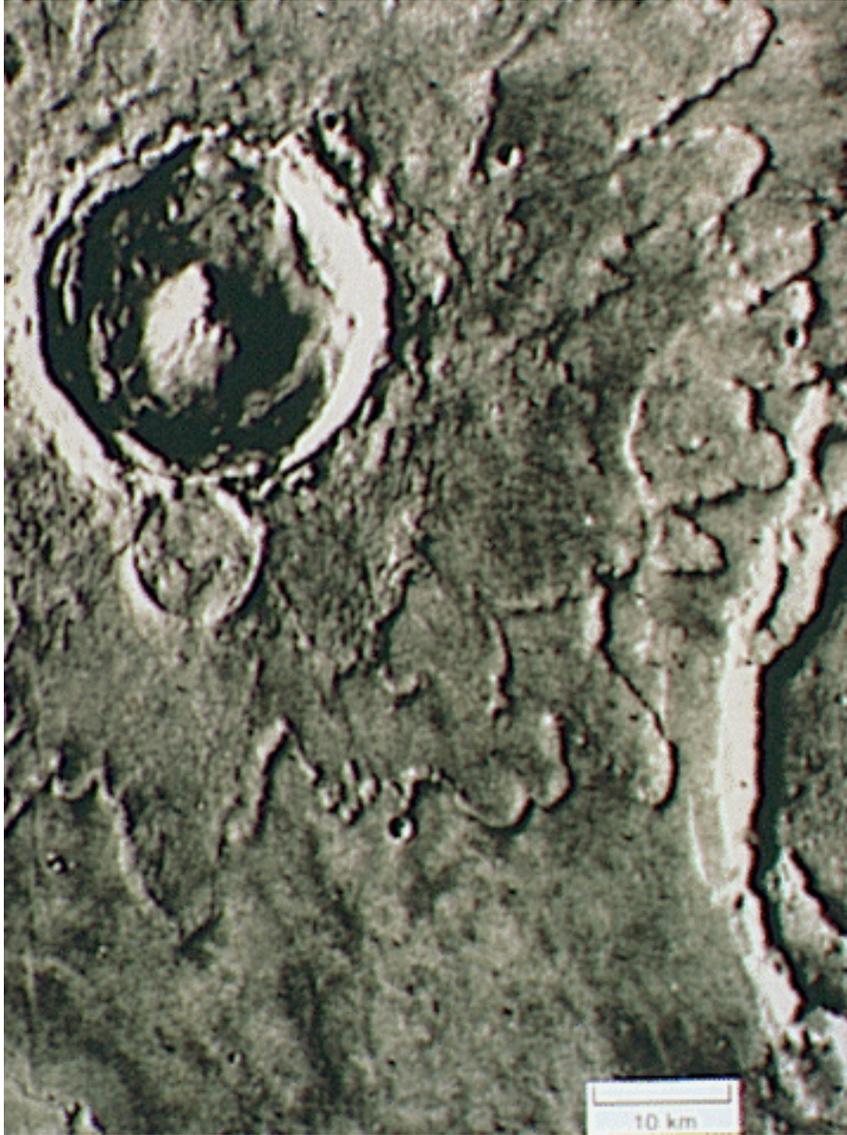
## Water on Mars

Photographic evidence tells us that significant amounts of water once existed on Mars.

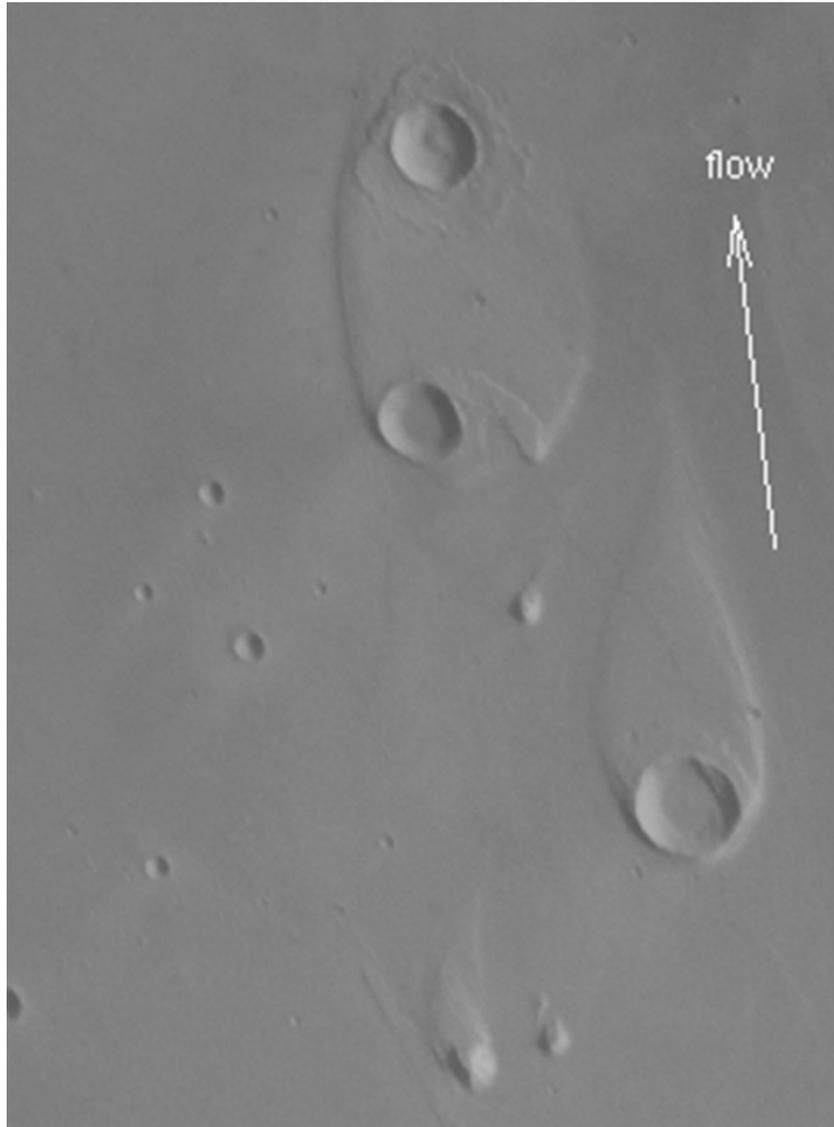
- How much water was on the surface?
- How long was it there?
- Where did it go?



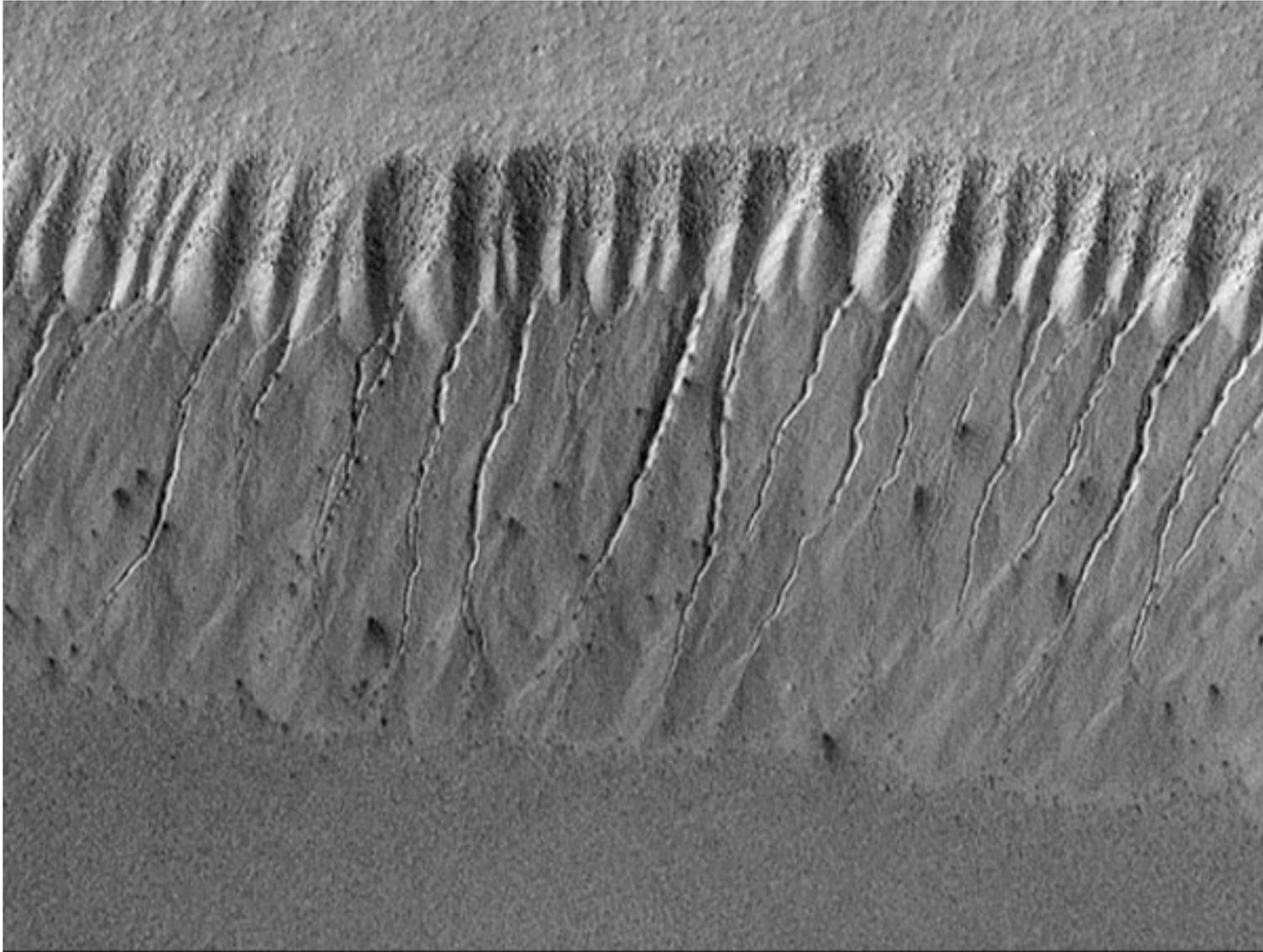
# “Splosh Craters”



# “Streamlined Flow” Features



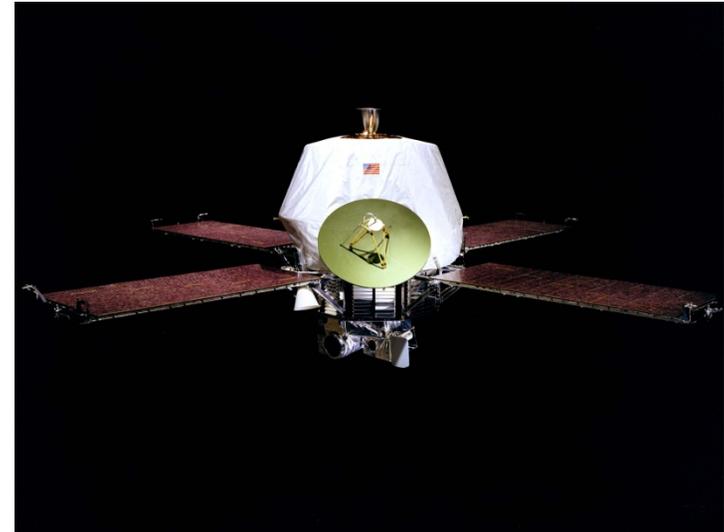
# Water Runoff Gullies



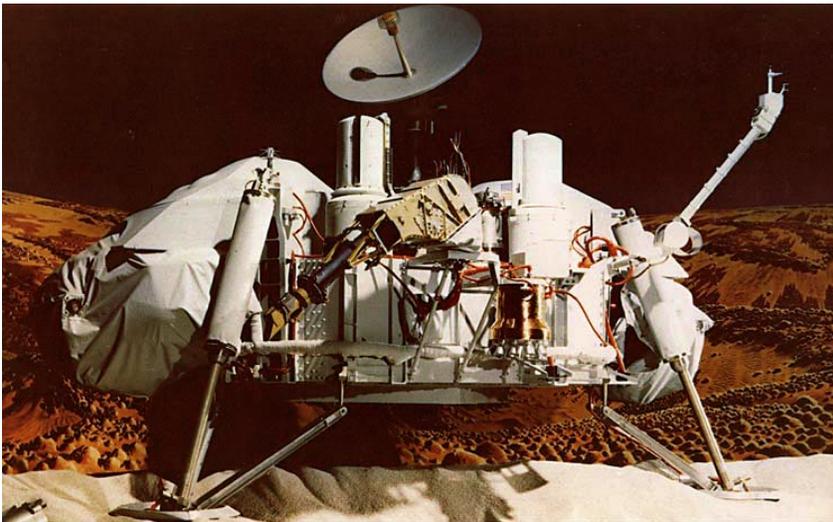
# Robotic Exploration of Mars (Not a complete list!)



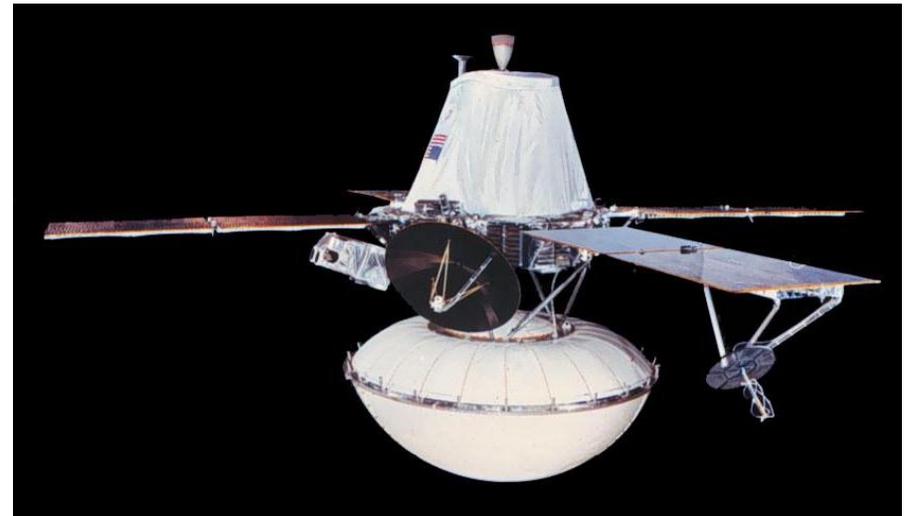
**Mariner 4 (1965)**



**Mariner 9 (1971)**



**Viking Lander (1976)**

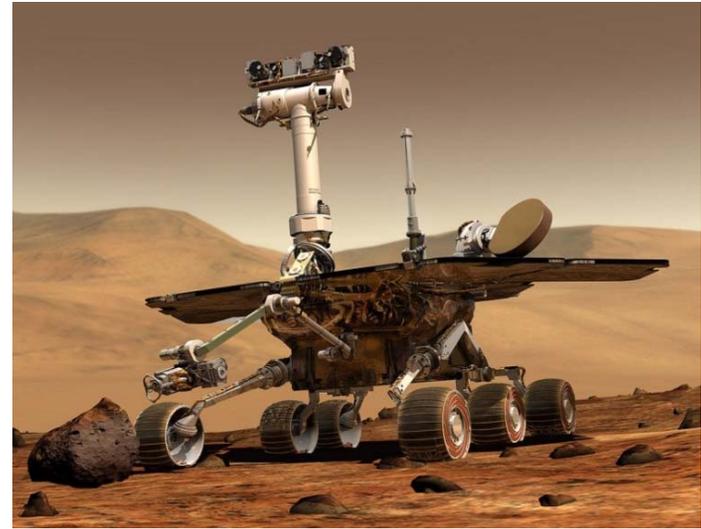


**Viking Orbiter**

## Robotic Exploration of Mars (Continued)



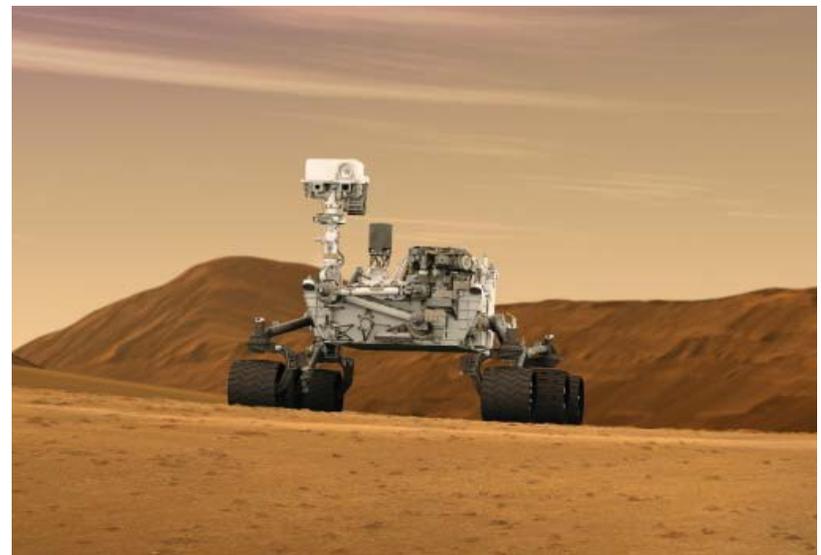
**Pathfinder (1997)**



**Mars Exploration Rover (2004)**



**Phoenix Mars Mission (2008)**



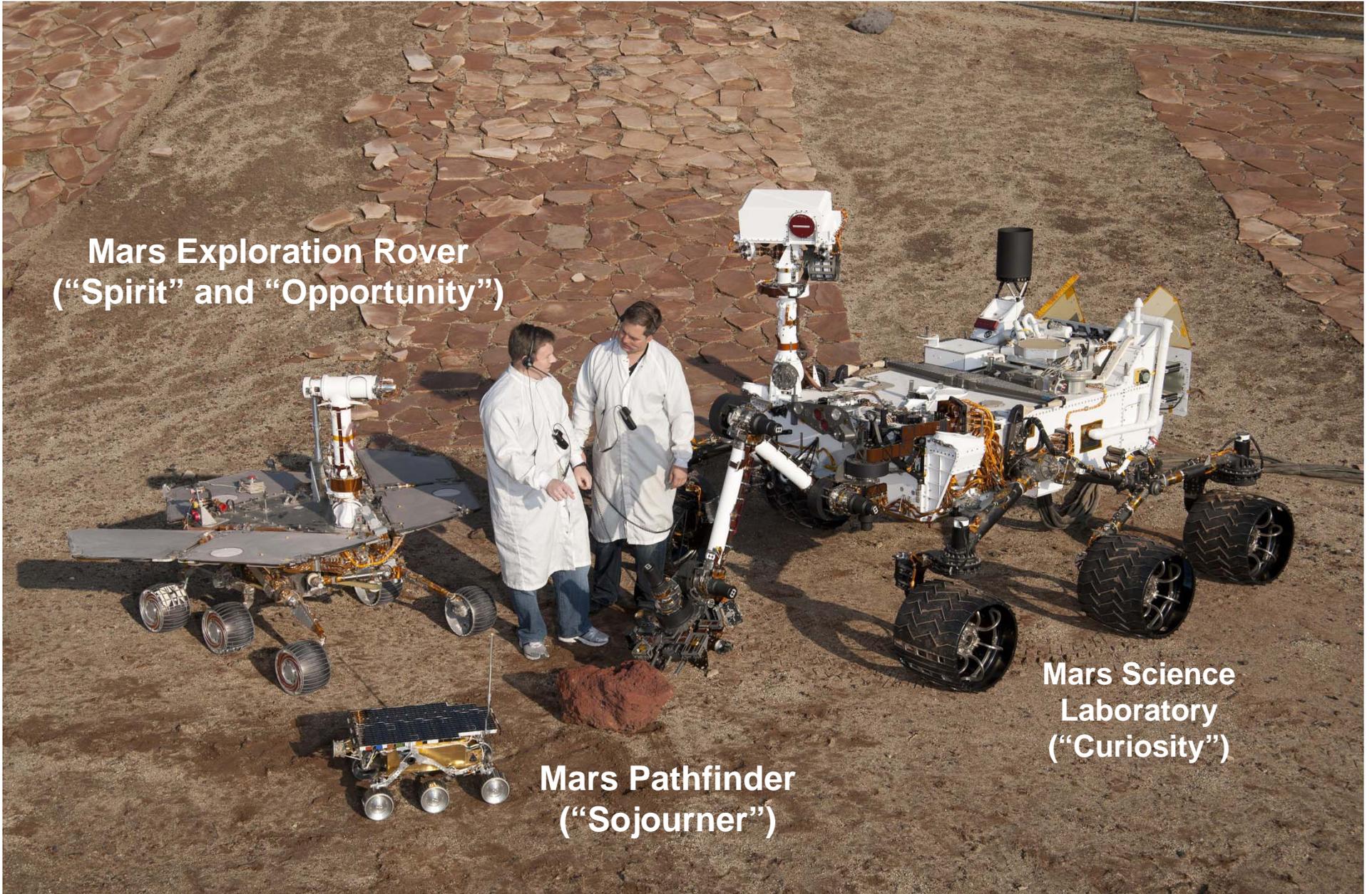
**Mars Science Laboratory (2012)**

# Mars Surface Rovers

Mars Exploration Rover  
("Spirit" and "Opportunity")

Mars Science  
Laboratory  
("Curiosity")

Mars Pathfinder  
("Sojourner")



**Curiosity is twice the size of Mars rovers Spirit and Opportunity and five times as heavy.**

<b>165 lbs</b>	<b>Instruments</b>	<b>11 lbs</b>
<b>1,982 lbs</b>	<b>Weight</b>	<b>384 lbs</b>

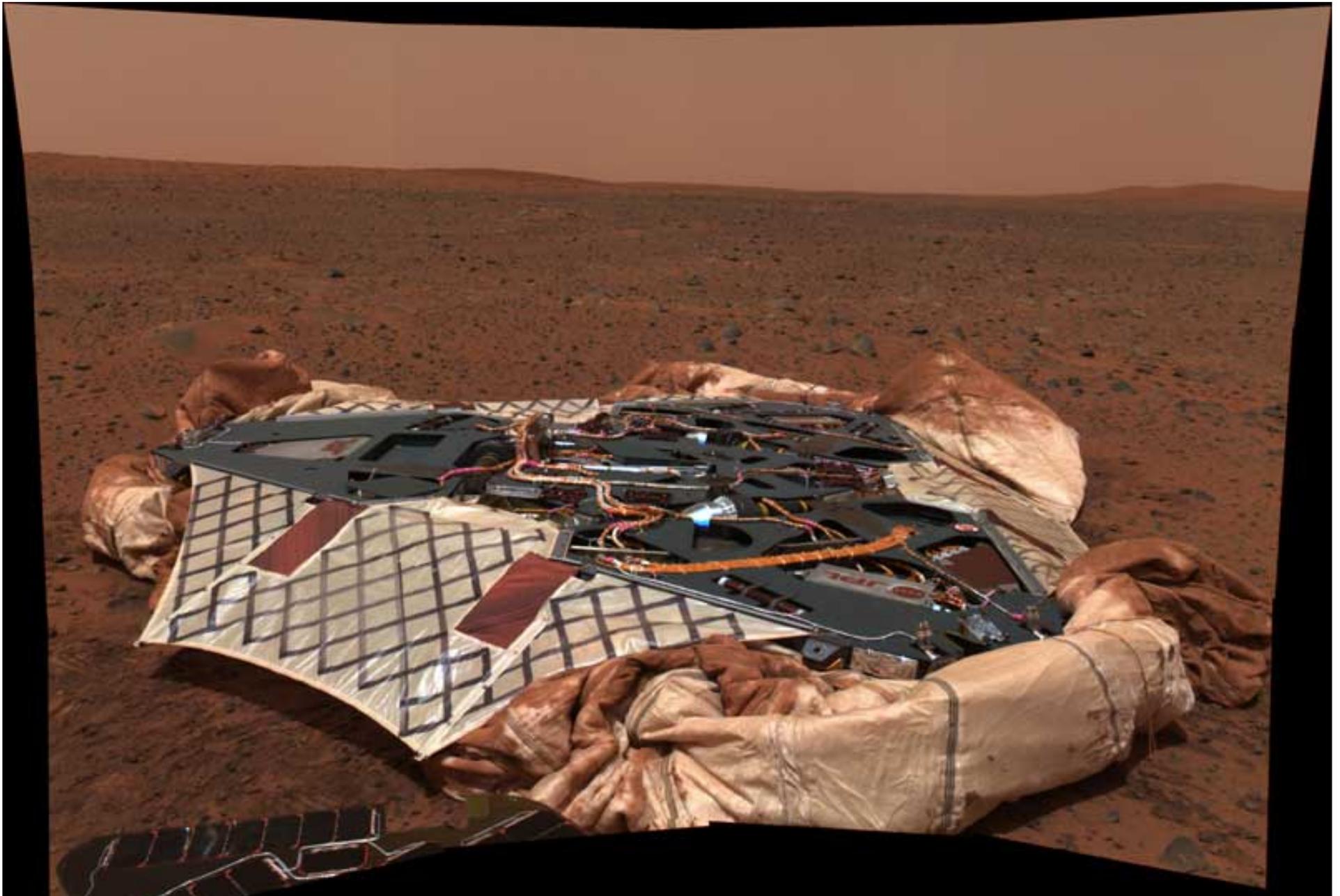


**Curiosity**



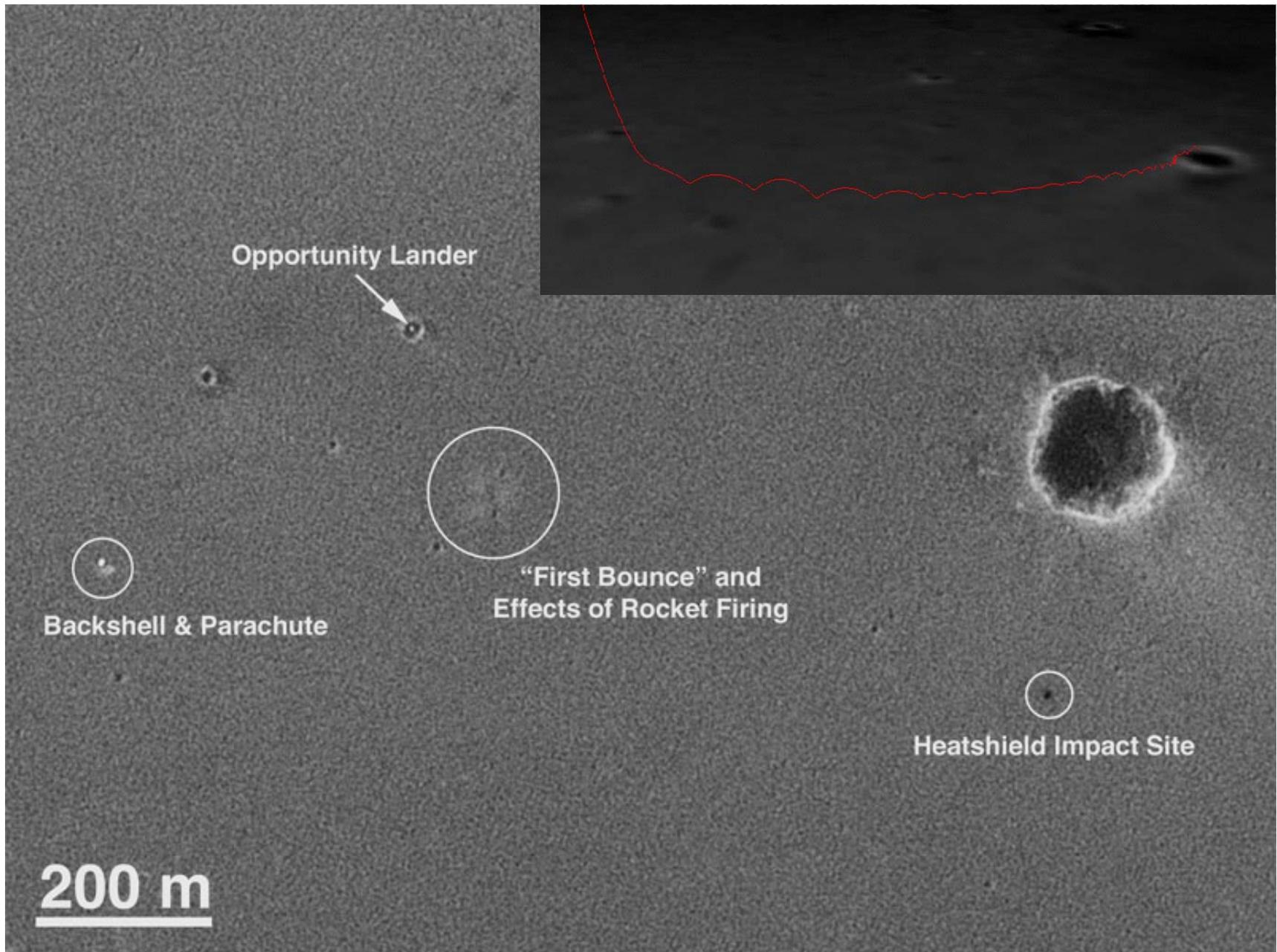
**Mars Exploration Rover**

# ***Columbia Memorial Station – Spirit – 3 Jan 04***

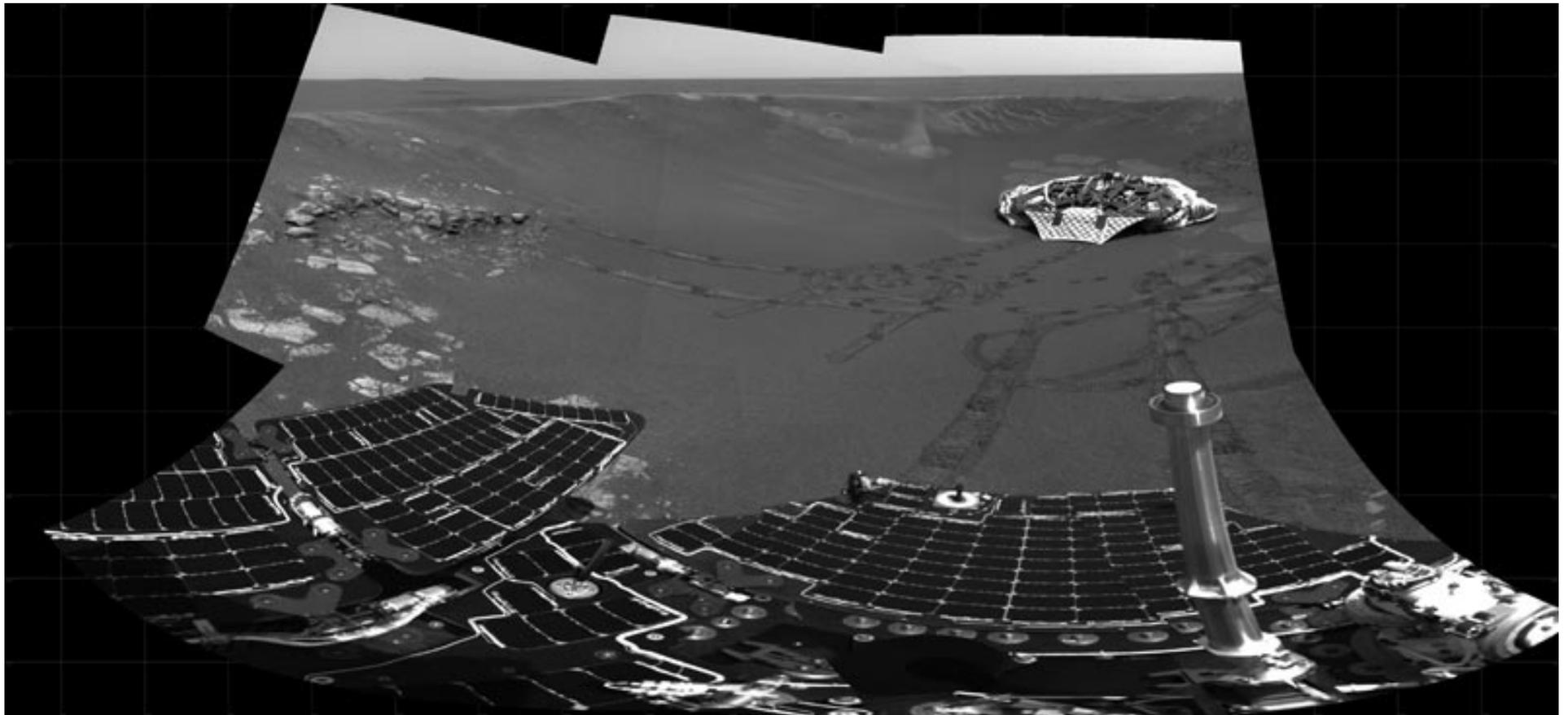




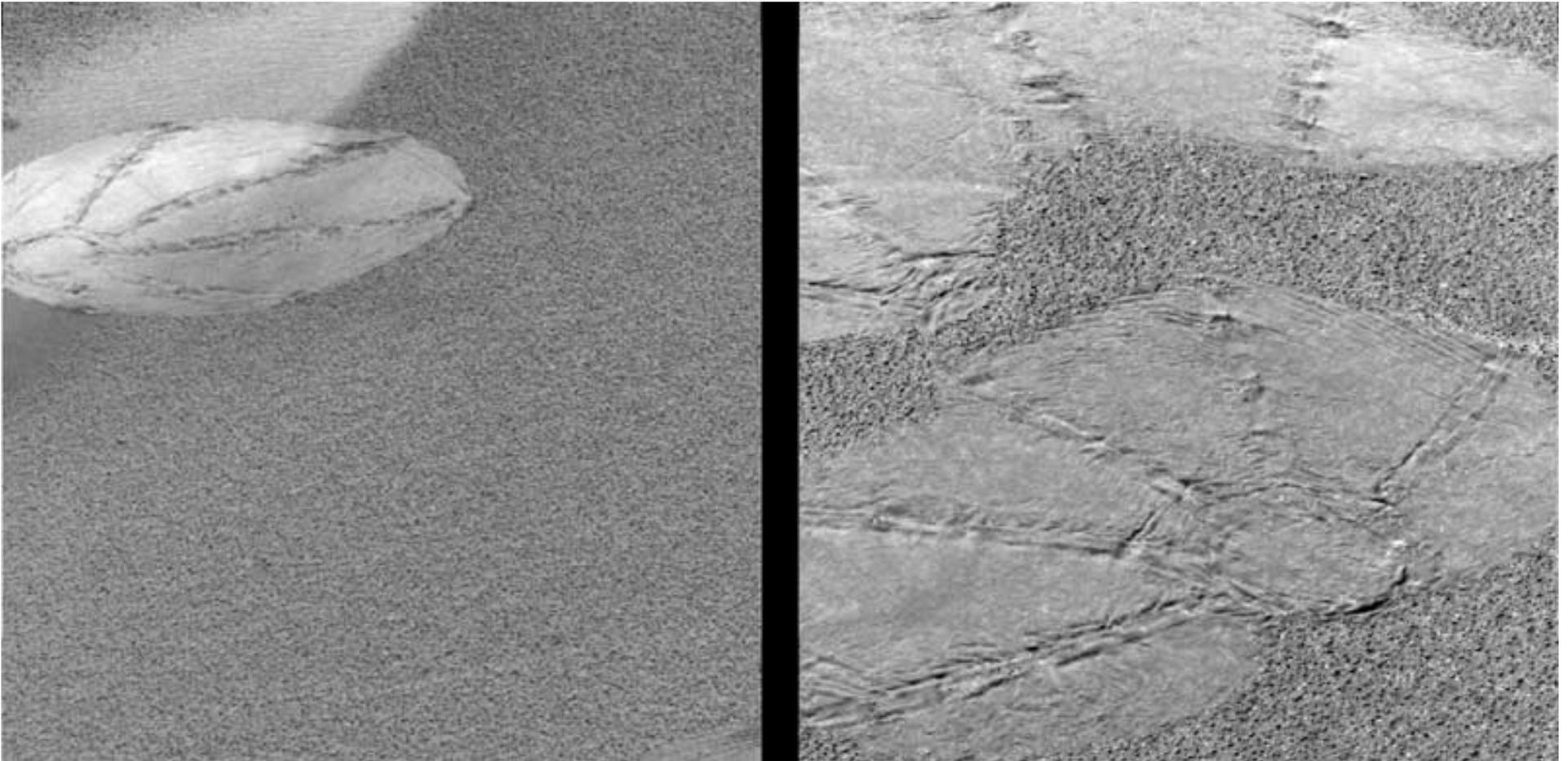
# Opportunity: An Interplanetary “Hole-in-One”



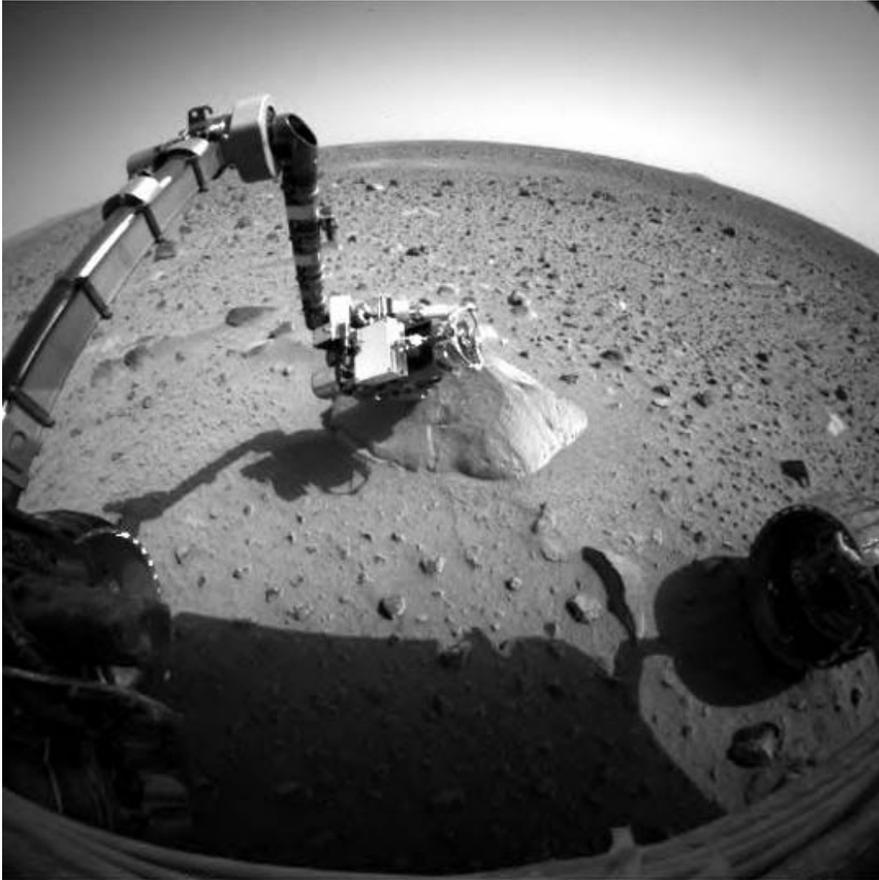
# ***Challenger* Memorial Station – Opportunity – 25 Jan 04**



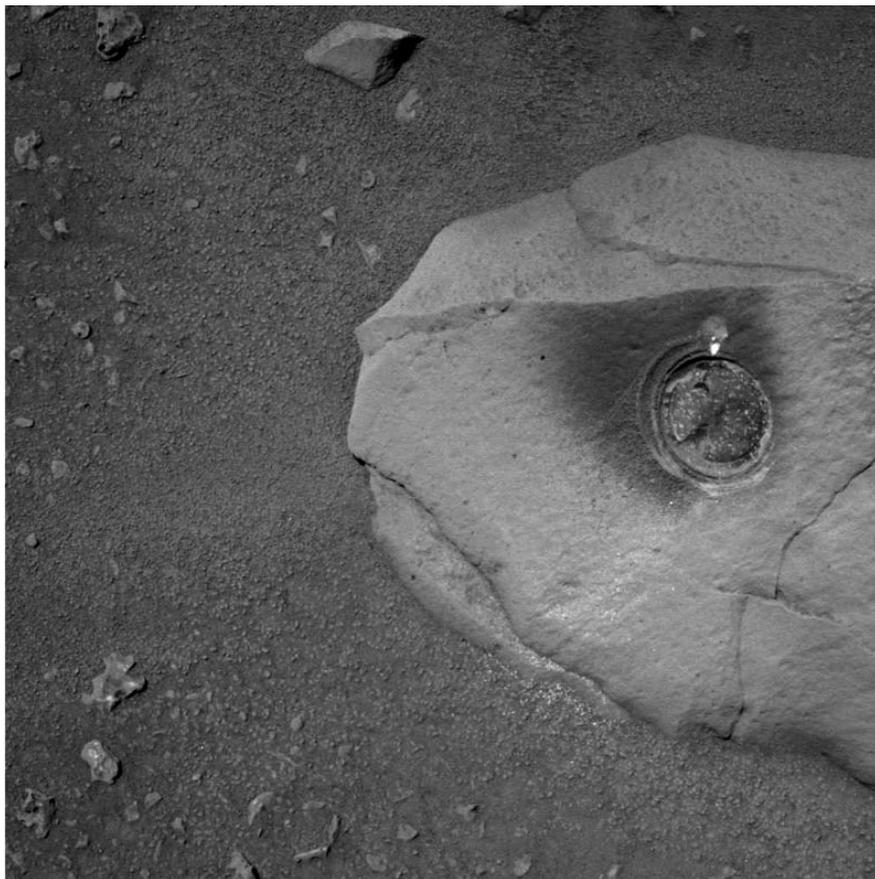
# Airbag “Footprints”



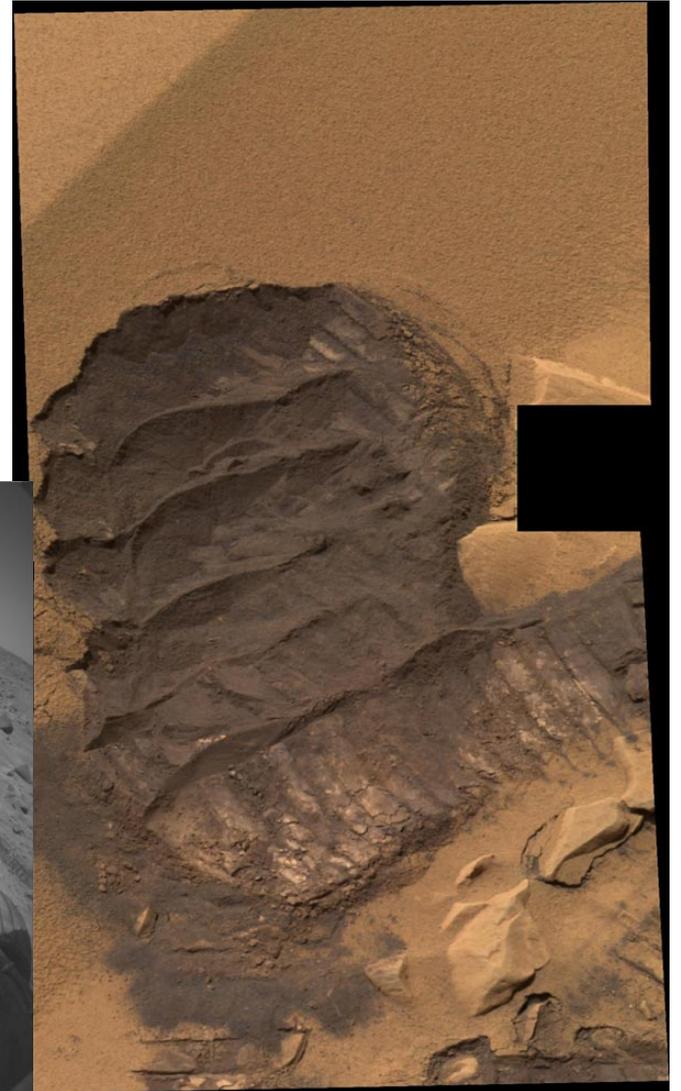
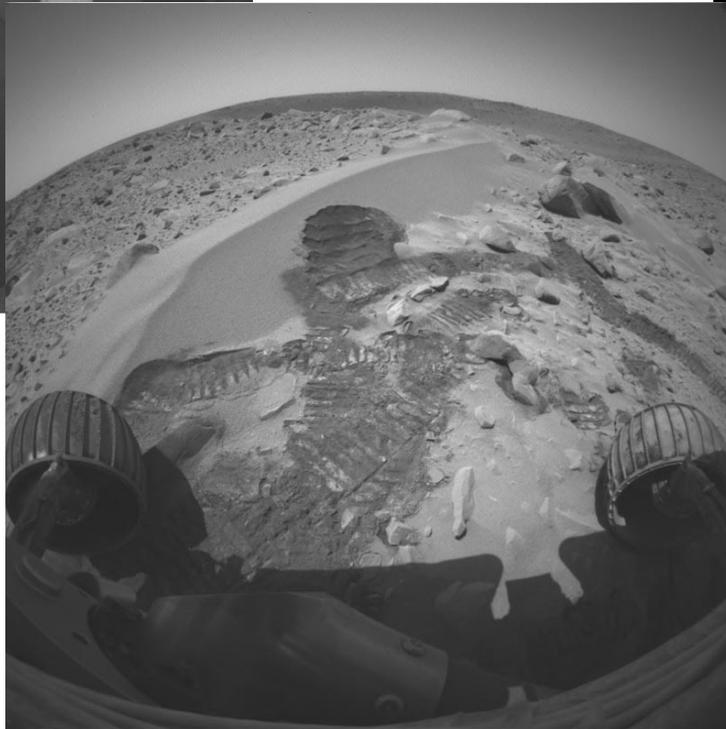
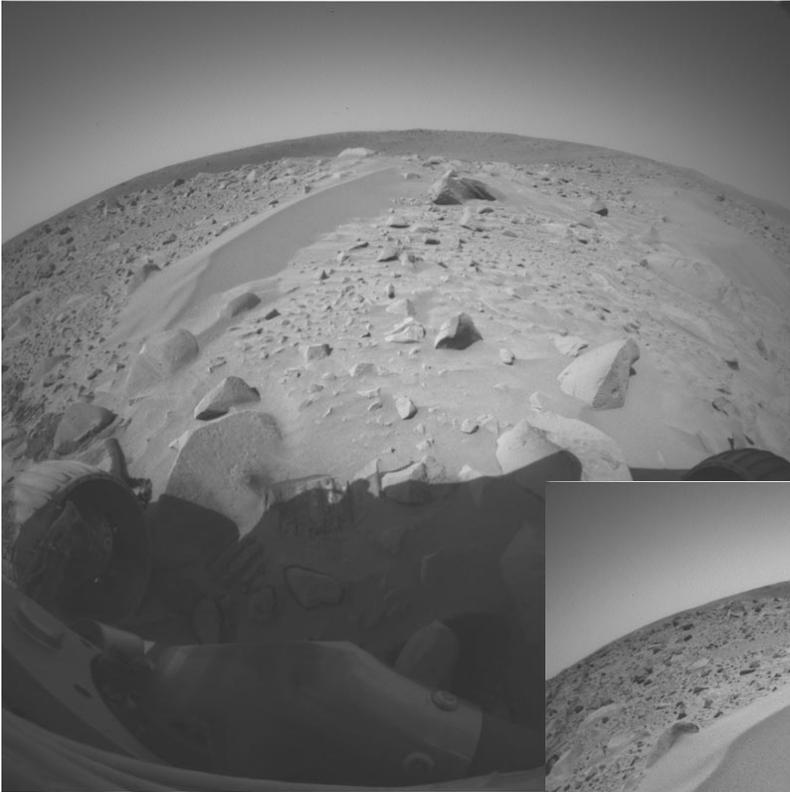
# Getting a Close Look at Adirondack



## Rock Abrasion Tool (Adirondack)



# The Right Scuff





# Mars Exploration Rover Status

- **Spirit Remains Silent**

- More than 1,300 commands were transmitted to Spirit as part of a recovery effort
- No communication has been received from Spirit since March 22, 2010.
- The project concluded the Spirit recovery efforts on May 25, 2011.
- 2210 days of operation on the surface of Mars
- Total distance traveled: 4.80 miles (7730.50 meters).

- **Opportunity Well into its Ninth Year on Mars**

- Opportunity is currently positioned on the rim of Endeavour Crater conducting a contact study of clay minerals.
  - Rock Abrasion Tool (RAT), Microscopic Imager (MI) mosaic, followed by an Alpha Particle X-ray Spectrometer (APXS)
- As of Nov. 1, 2012, Opportunity has completed 3120 days of operation on the surface of Mars
- Total distance traveled: 21.78 miles (35,050.06 meters).

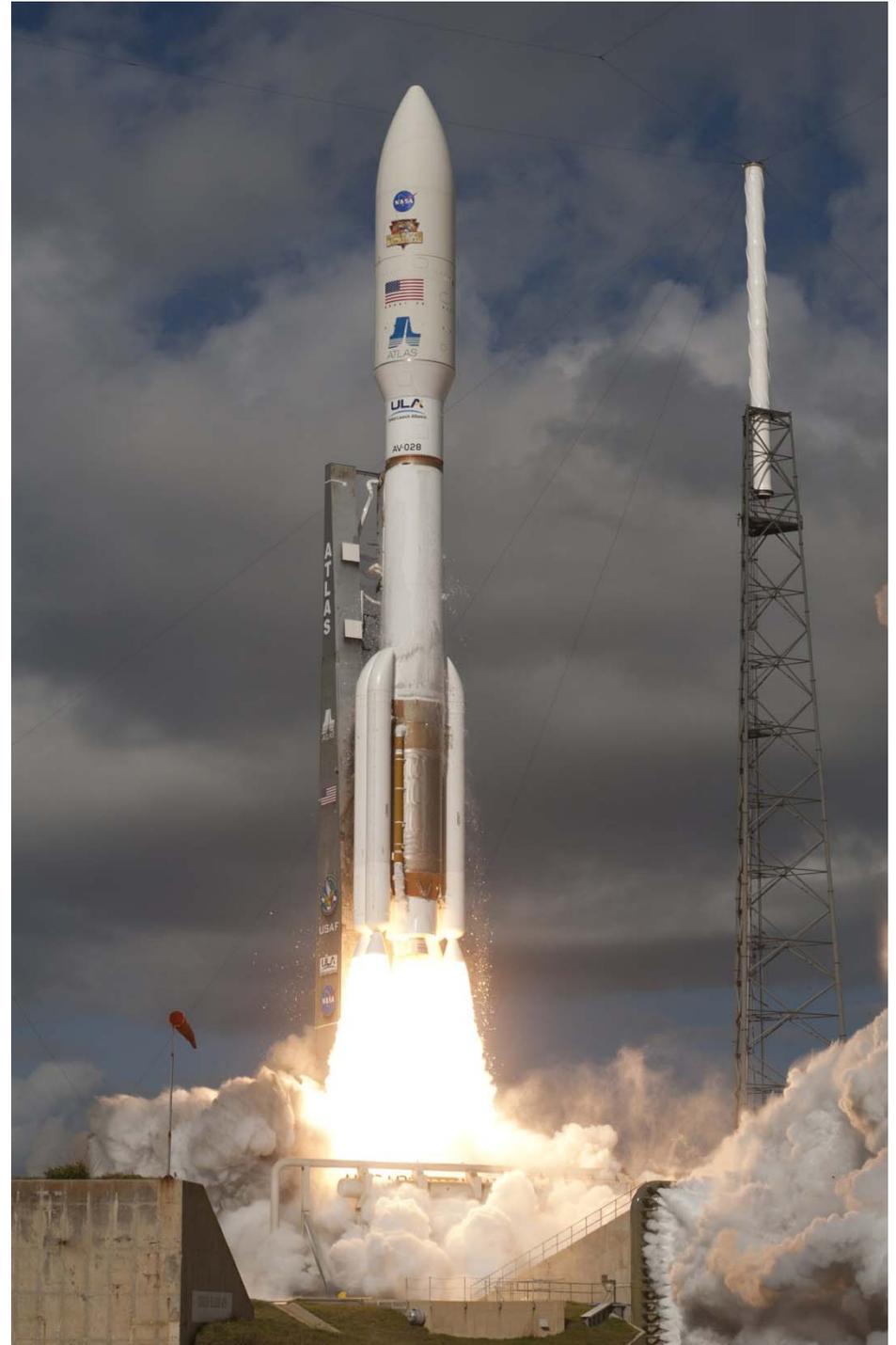


**Launch: 26 November 2011**

**Cape Canaveral AFS, FL**

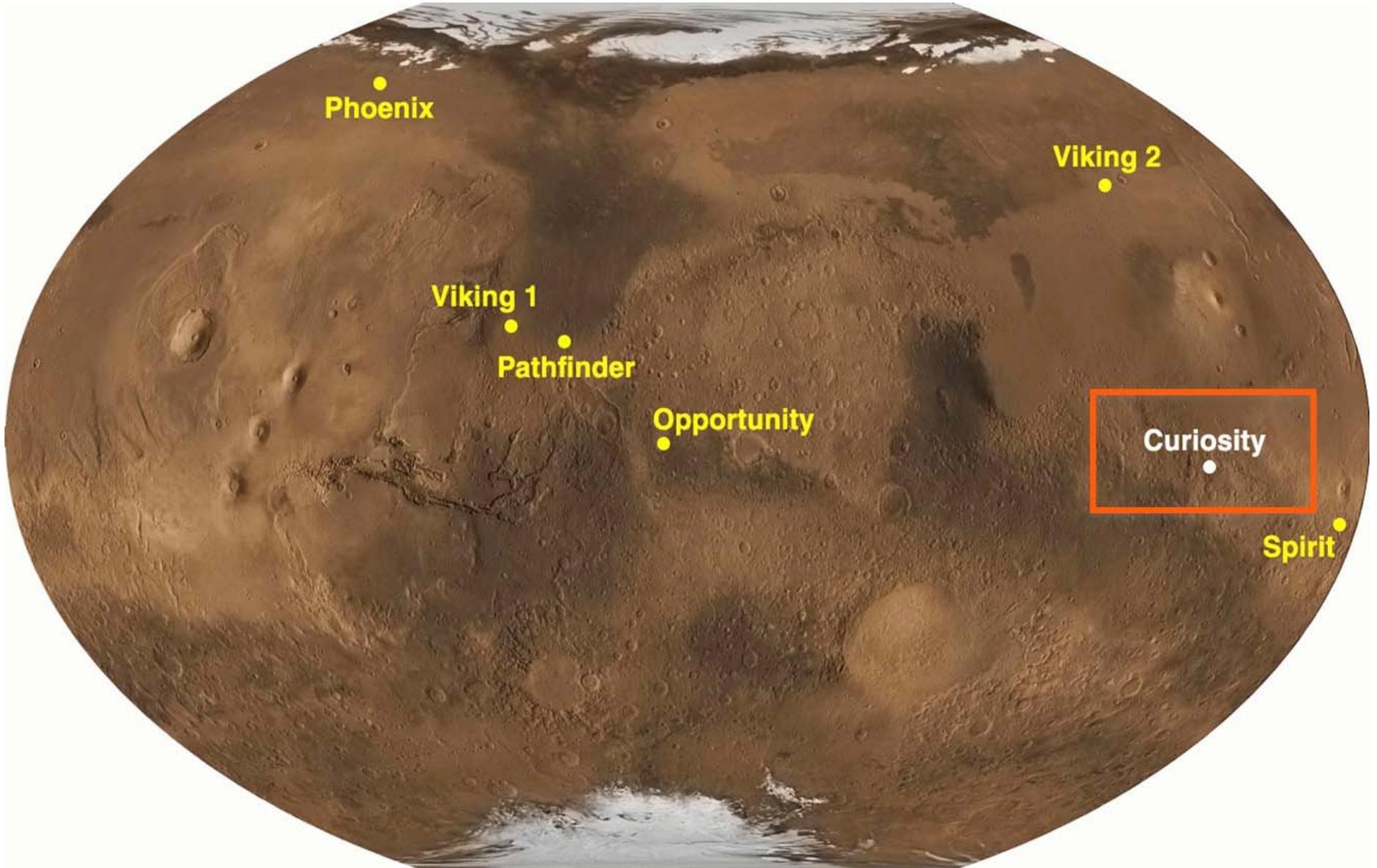
**Landing: 5 August 2012**

**Gale Crater, Mars**



# Global View of Mars

(Showing Previous Landing Sites)





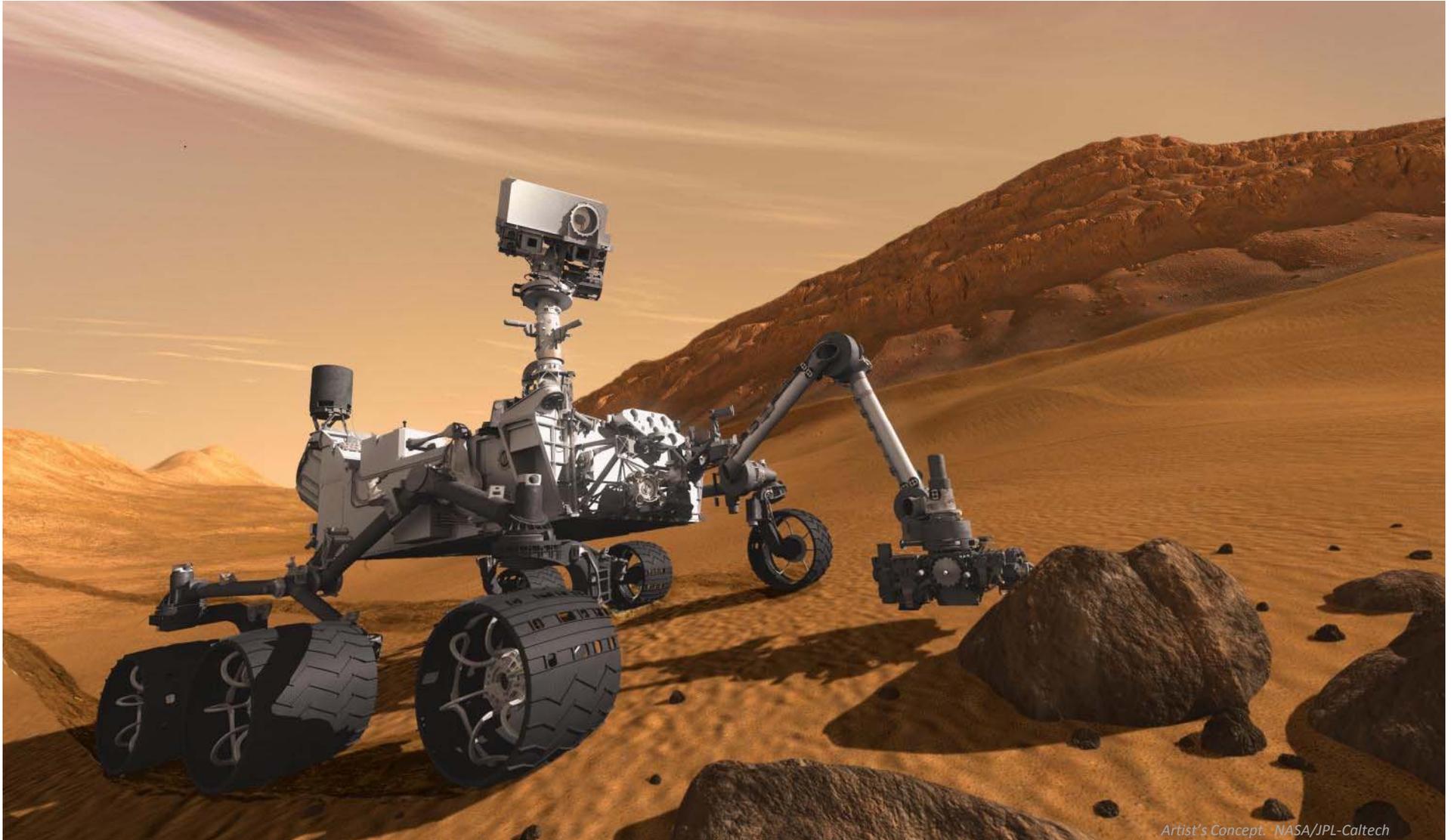
## Gale Crater

- **3.5 to 3.8 billion years old**
- **~96 miles in diameter**
- **Sedimentary rock layers**
- **Canyons and channels**
- **Central Peak Aeolis Mons (“Mt Sharp”) rises 18,000 feet above crater floor**



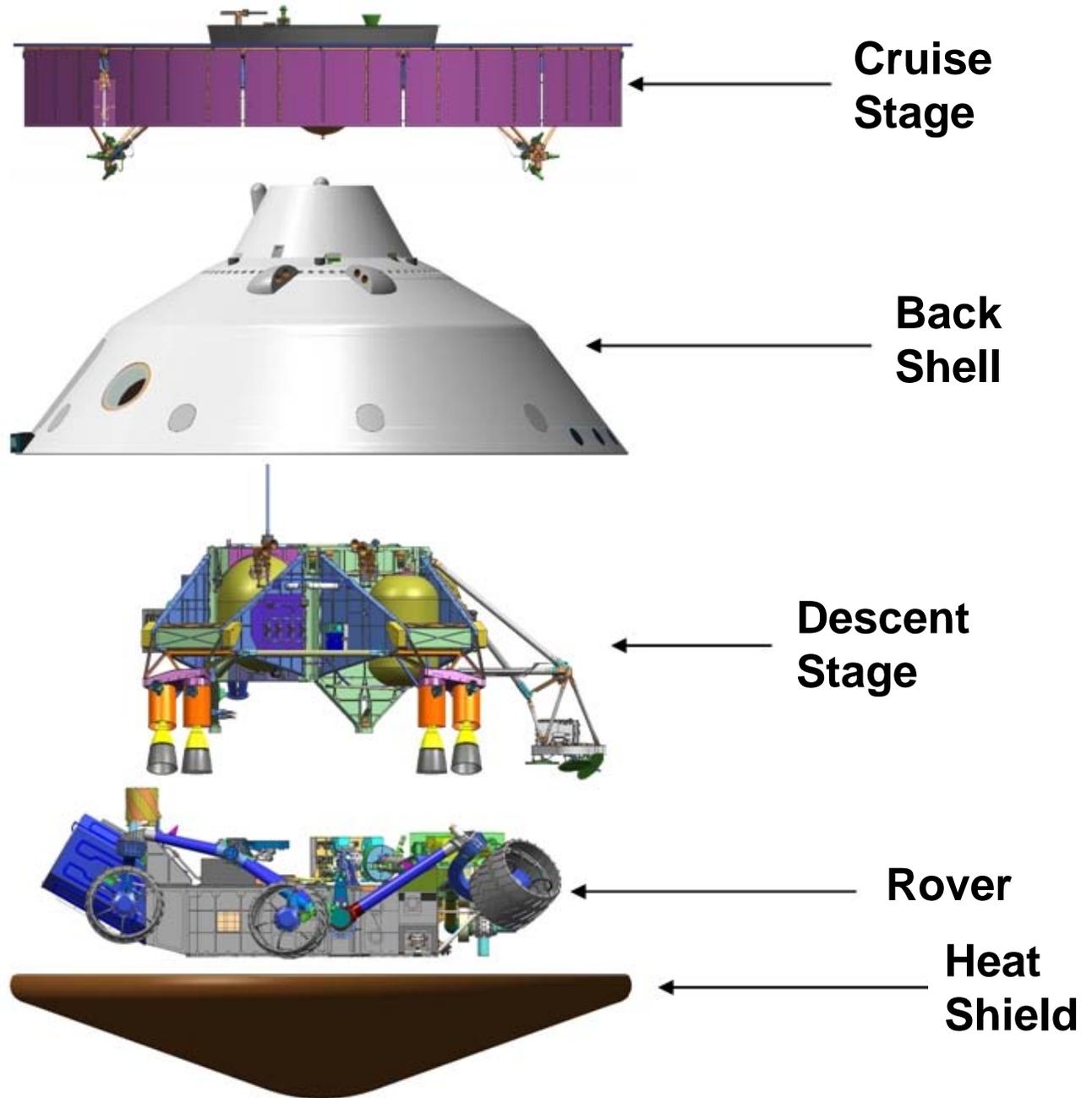
# ***CURIOSITY***

## **A Big Mars Rover for Big Mars Science!**

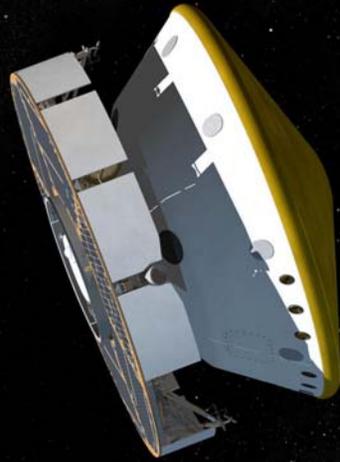


*Artist's Concept. NASA/JPL-Caltech*

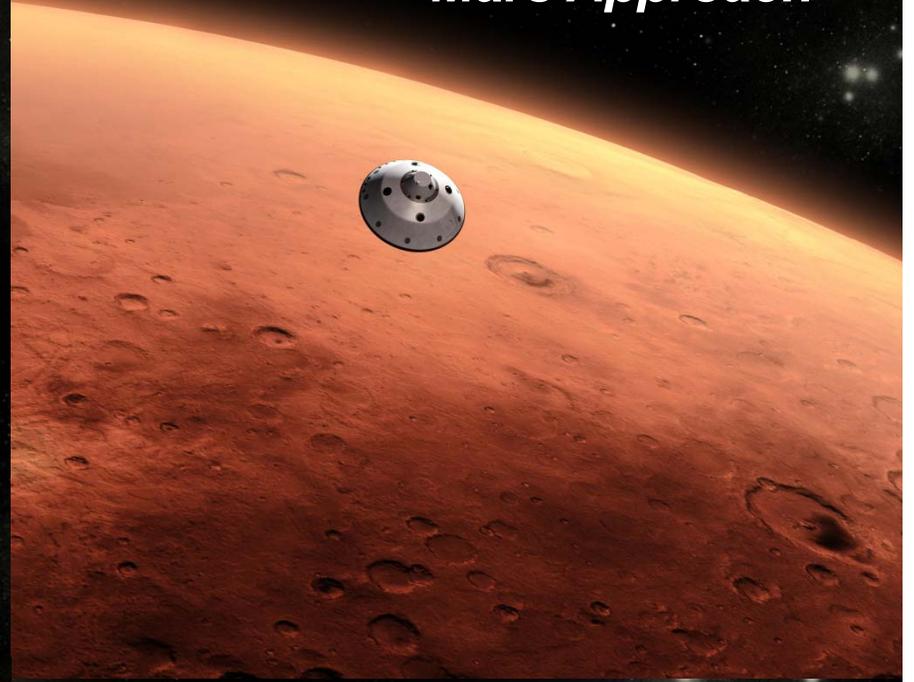
# MSL Spacecraft Assembly



*Cruise Phase*



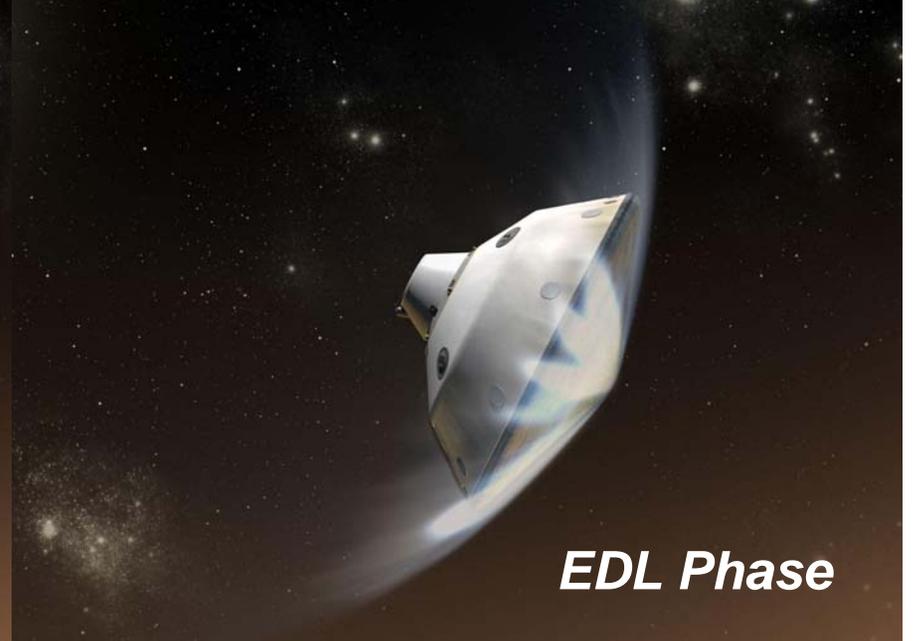
*Mars Approach*



*Guided Entry Phase*

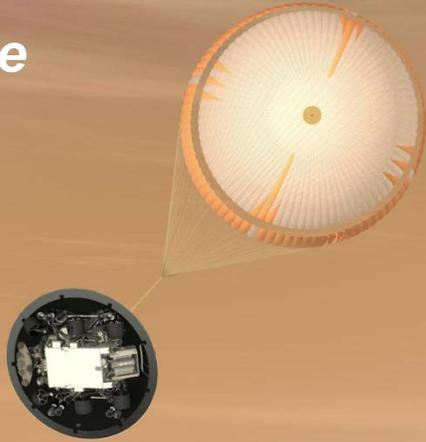


*EDL Phase*



# 5 August 2012 – Entry, Descent, and Landing (EDL) “7 Minutes of Terror”

*Parachute  
Phase*



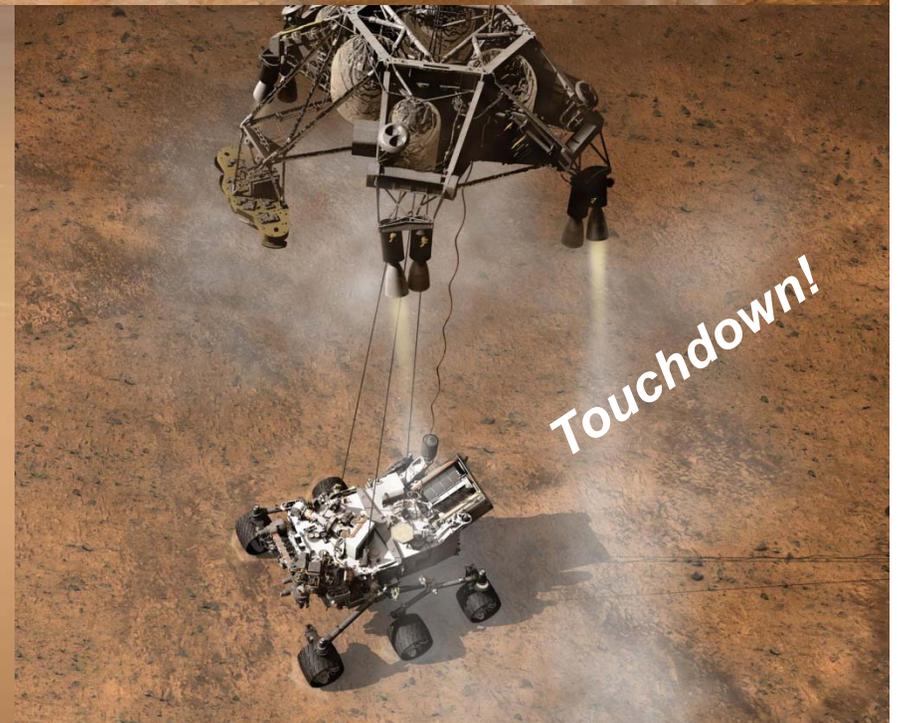
*Powered  
Descent*



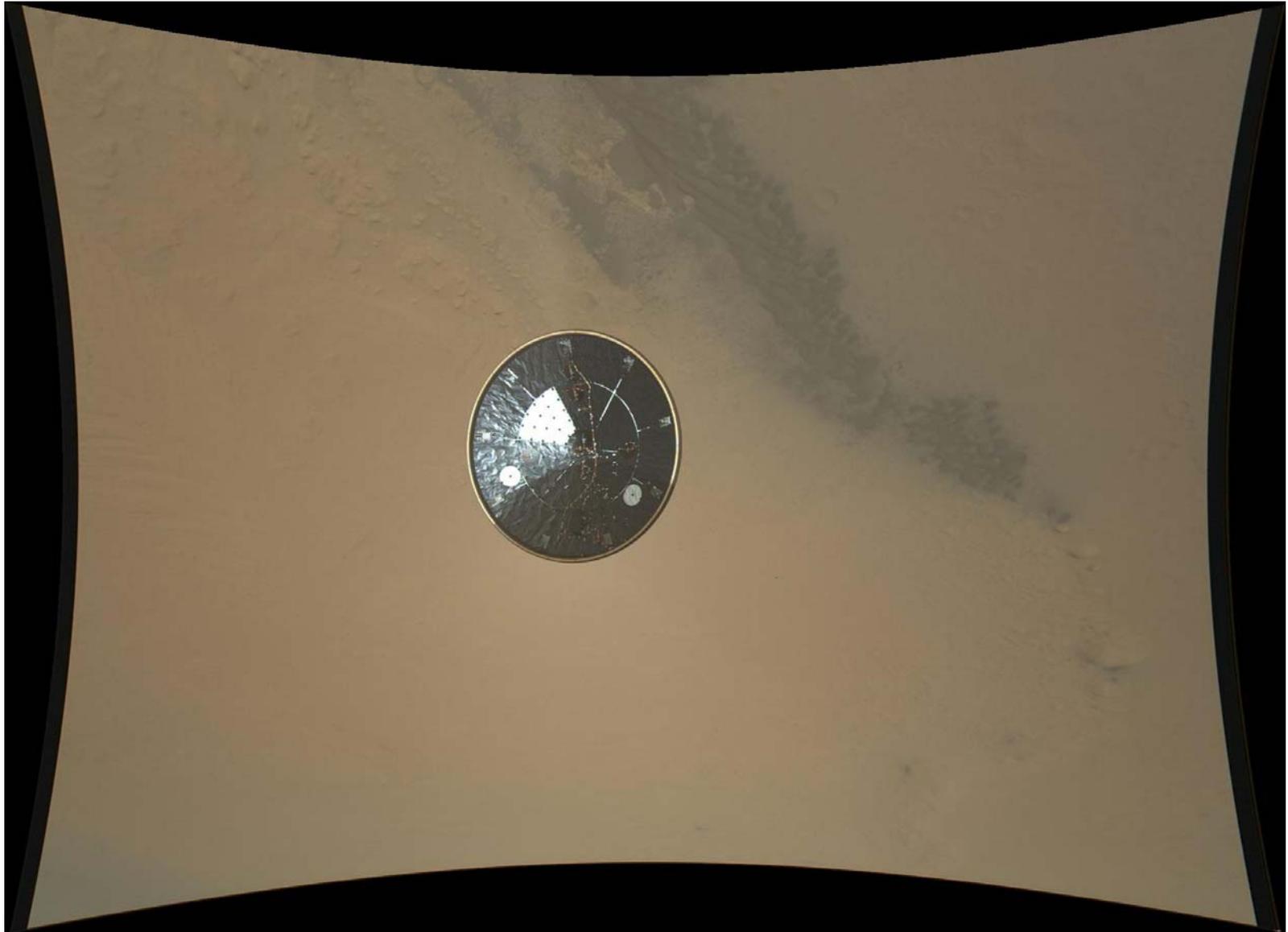
*Skycrane  
Phase*



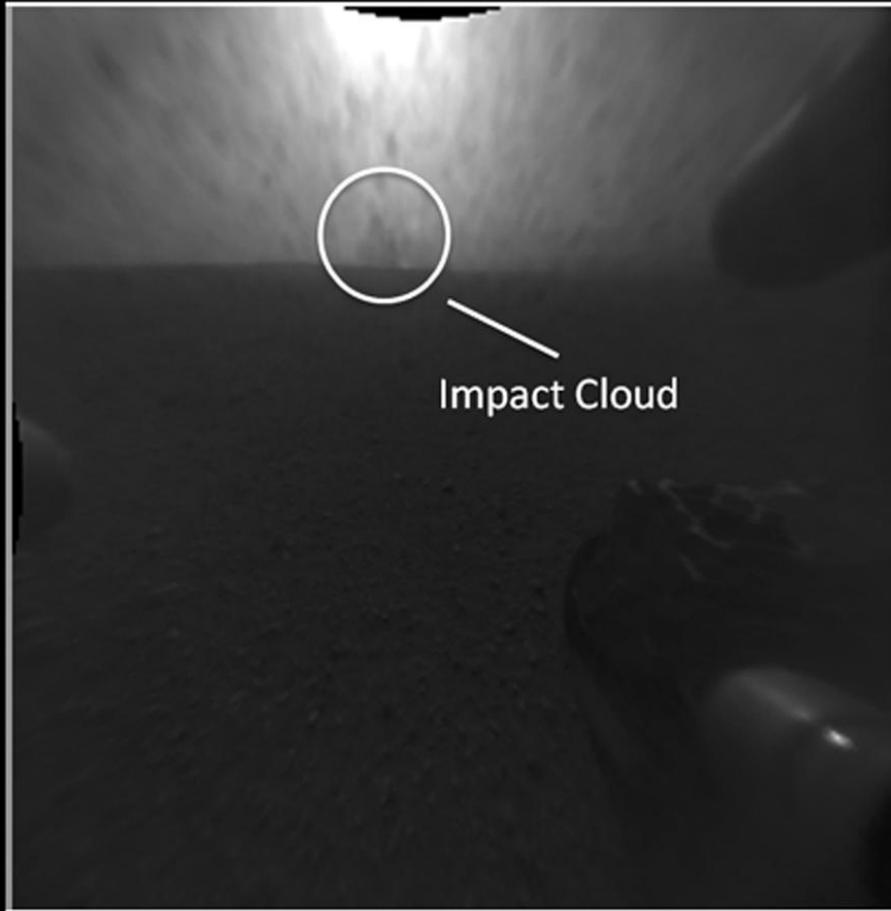
*Touchdown!*



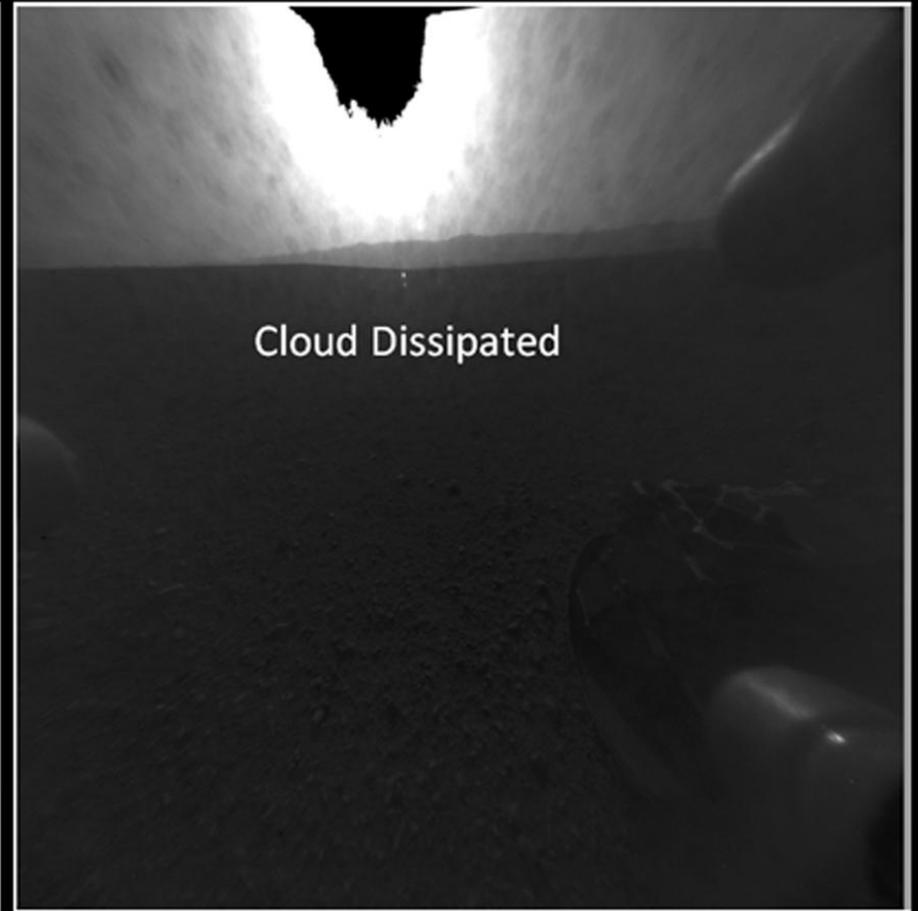
# Heat Shield Jettison



# Skycrane Impact

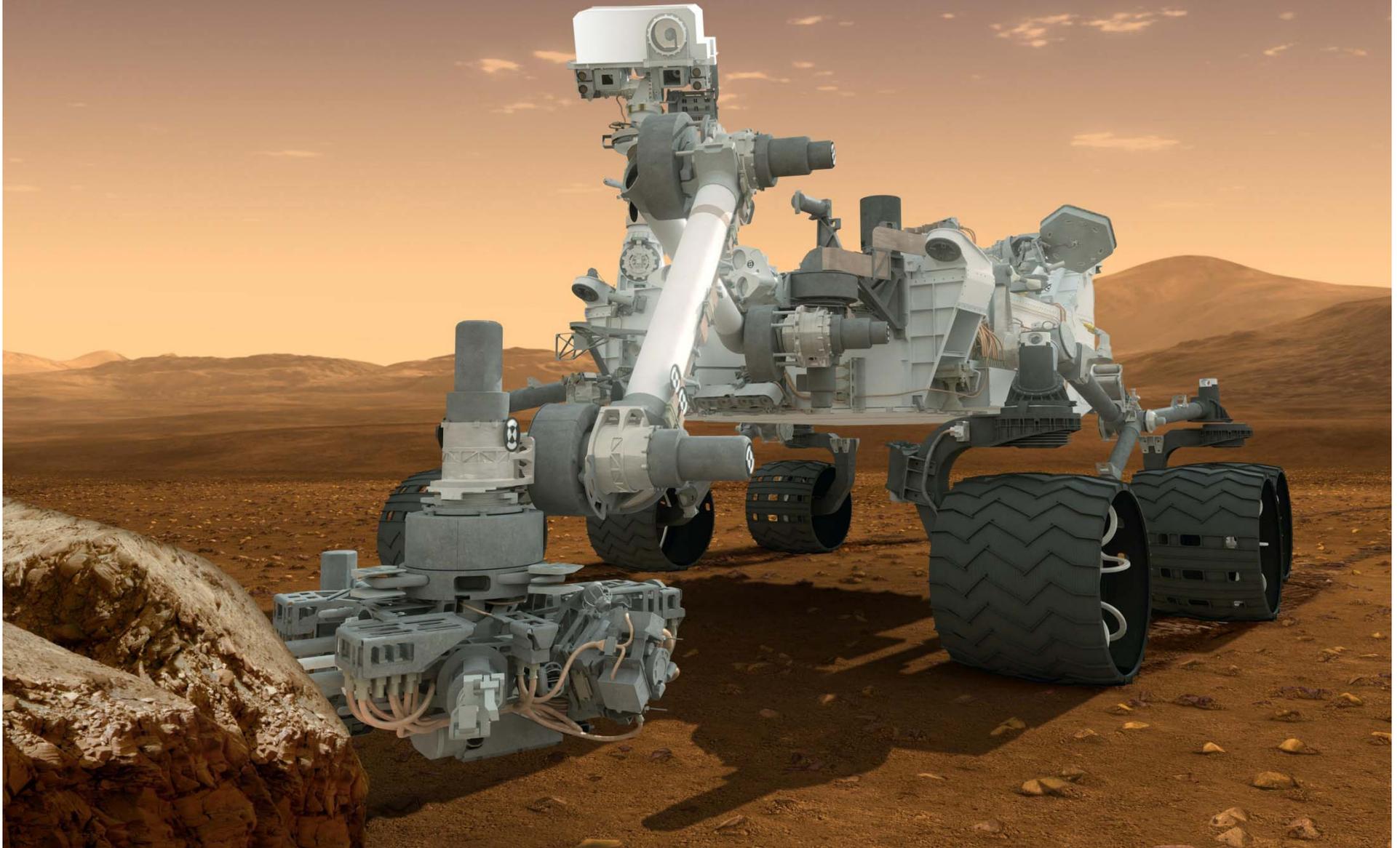


Left Rear Hazcam 05:18:38 UTC



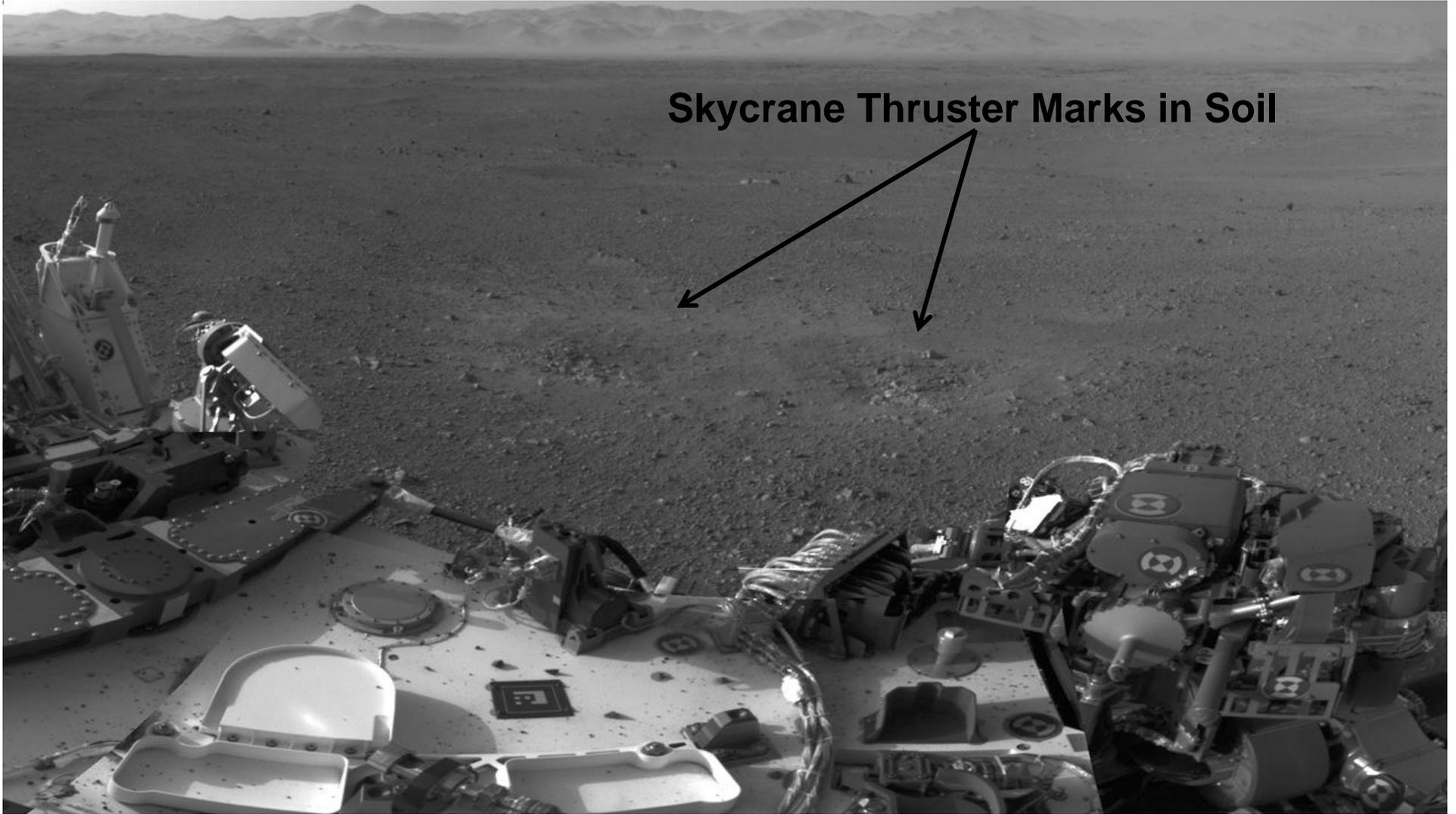
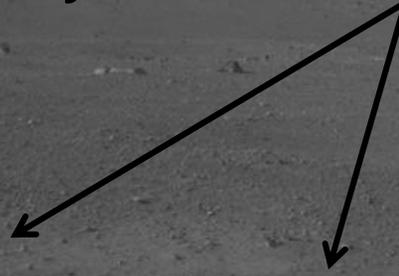
Left Rear Hazcam 06:03:27 UTC

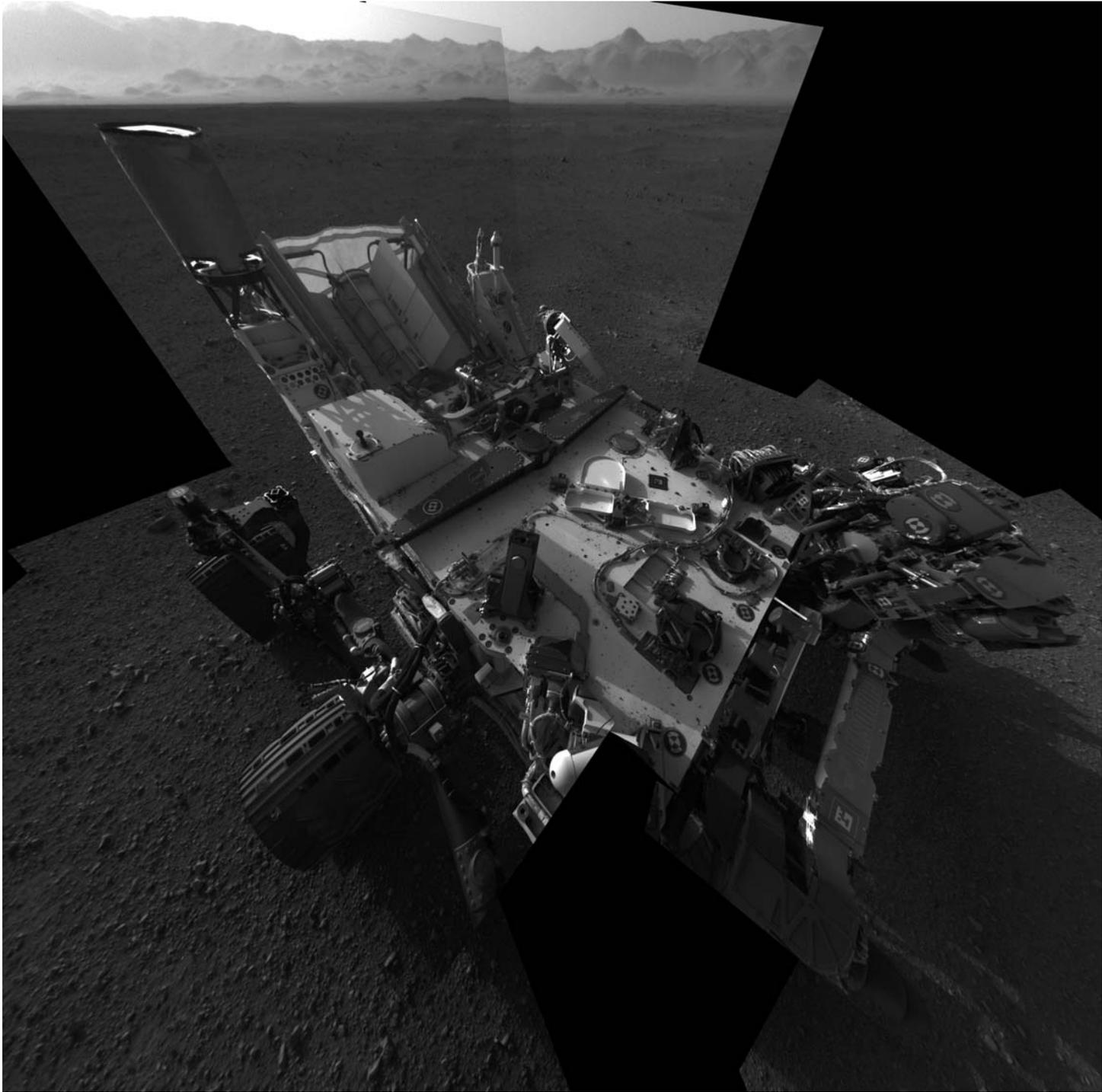
**MSL Rover “*Curiosity*”  
Explores the  
Surface of Mars**

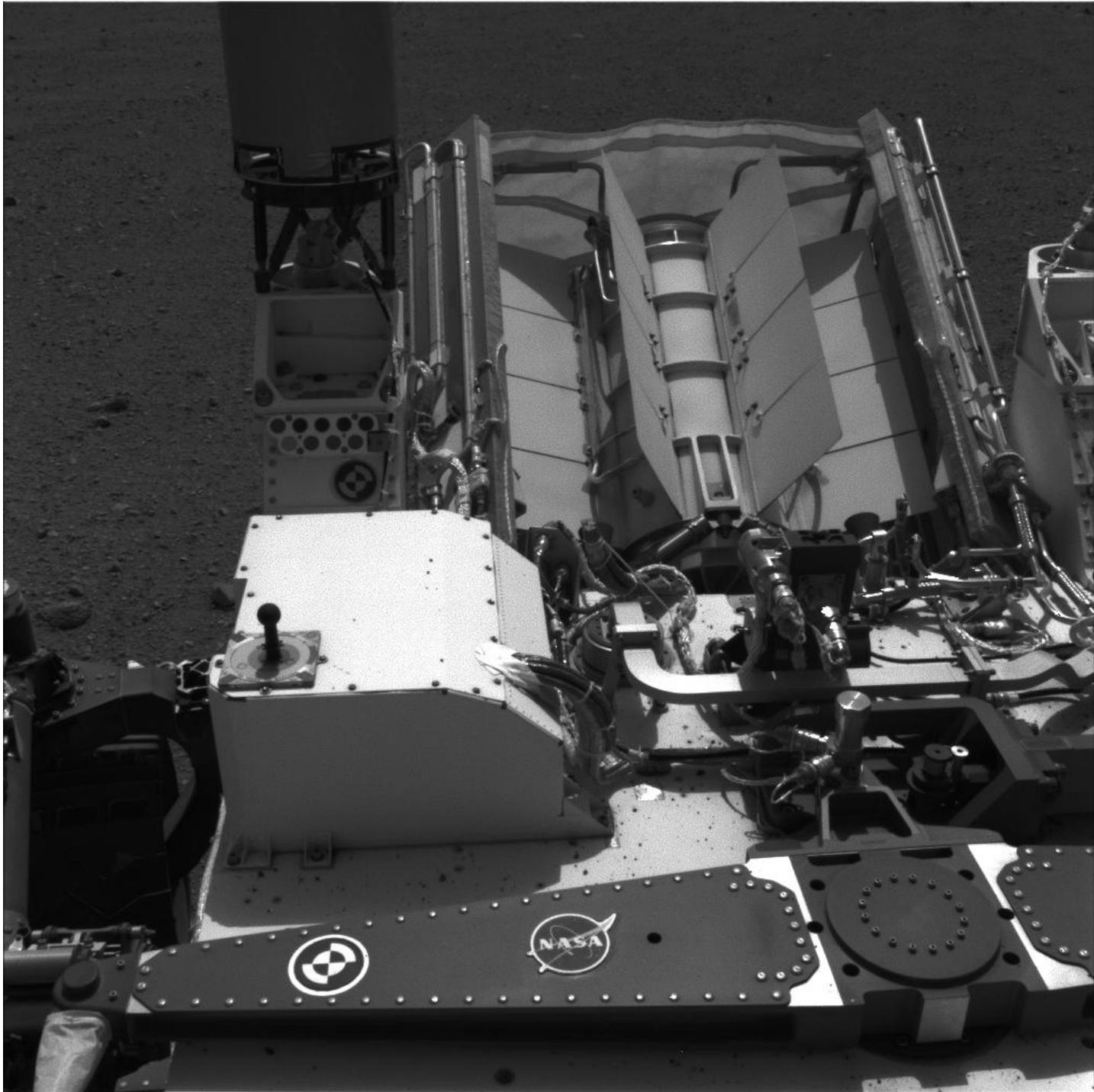


# Curiosity on the Surface of Mars

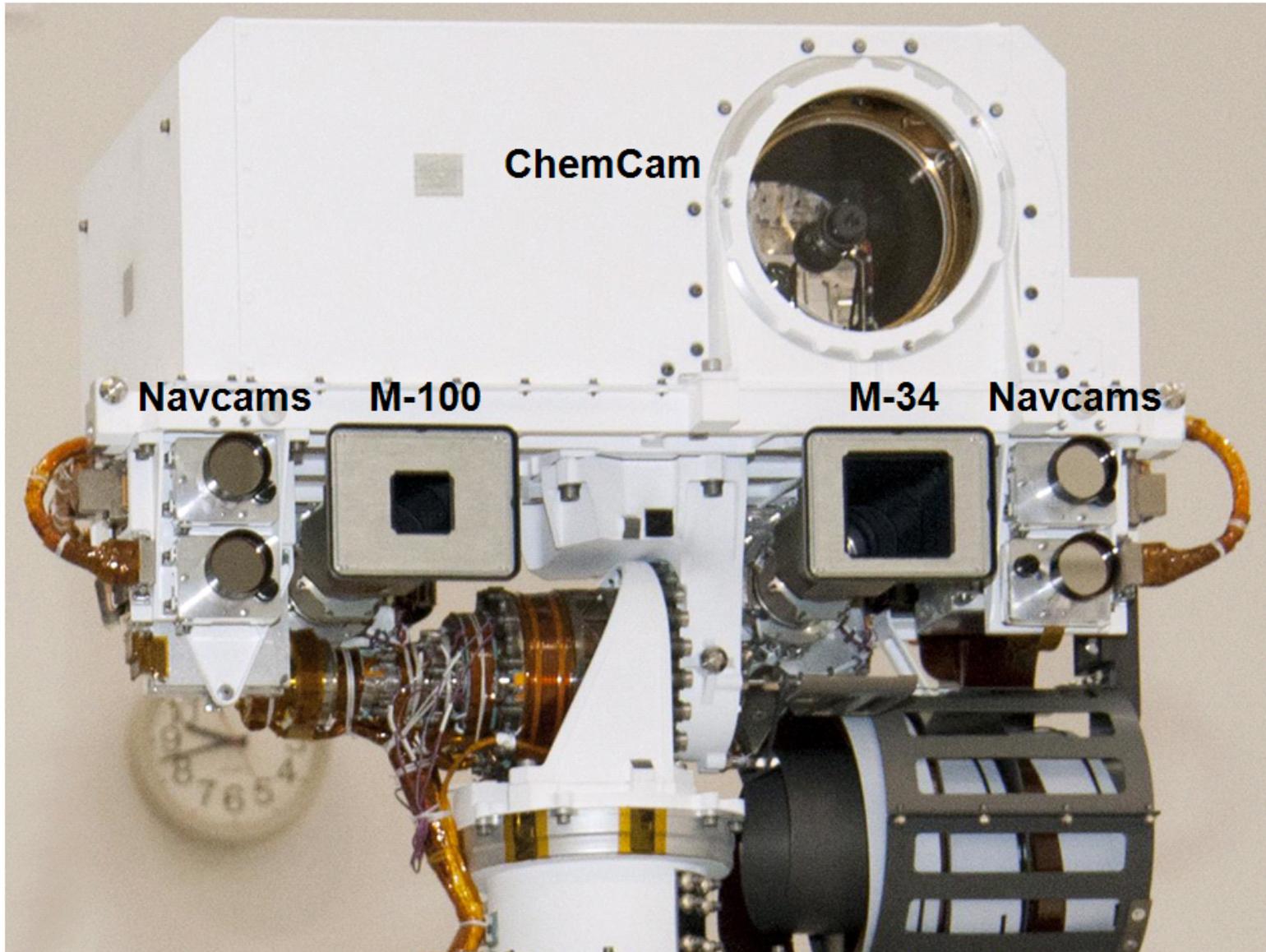
Skycrane Thruster Marks in Soil





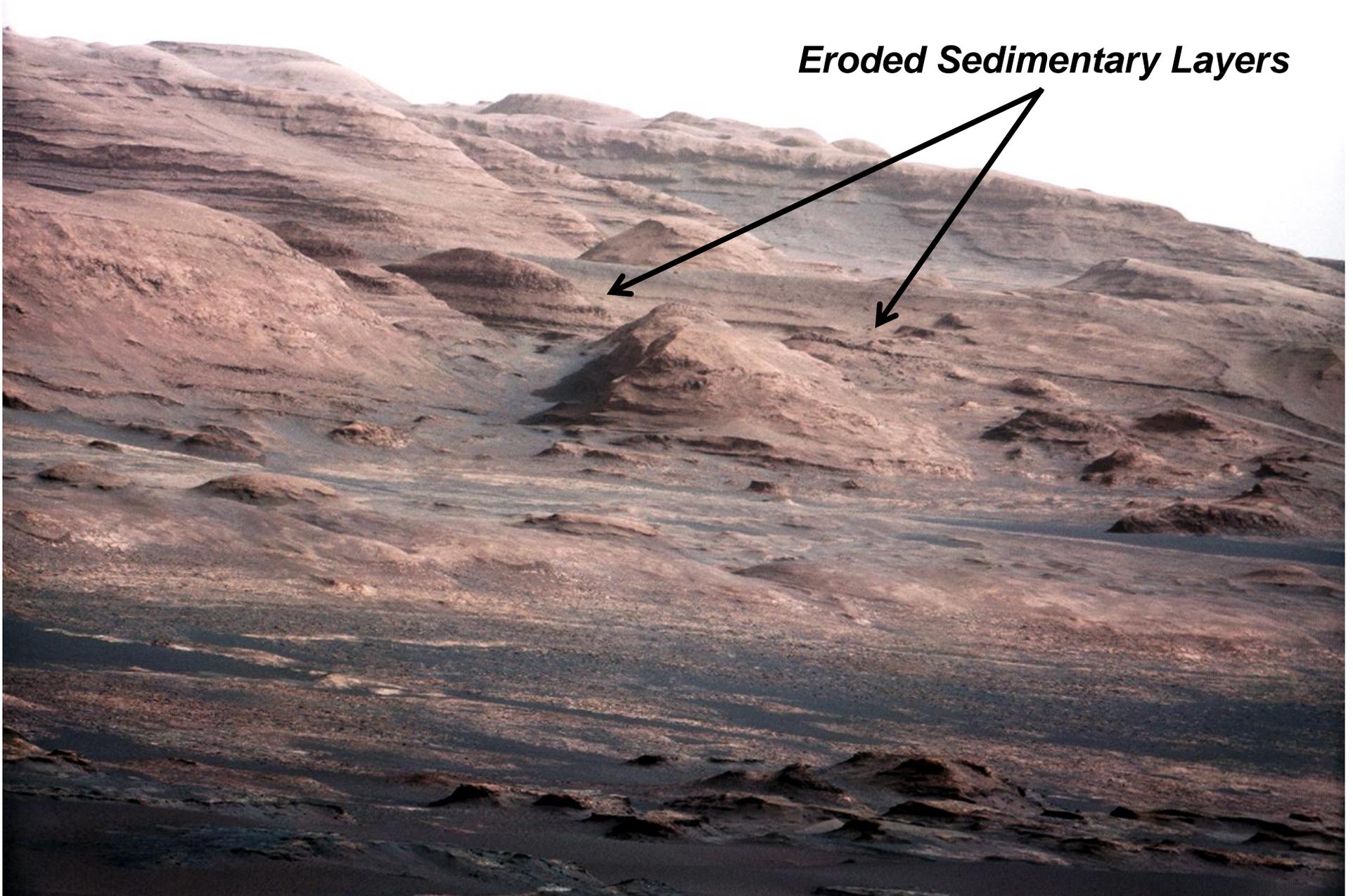


# Mast Camera (MastCam)

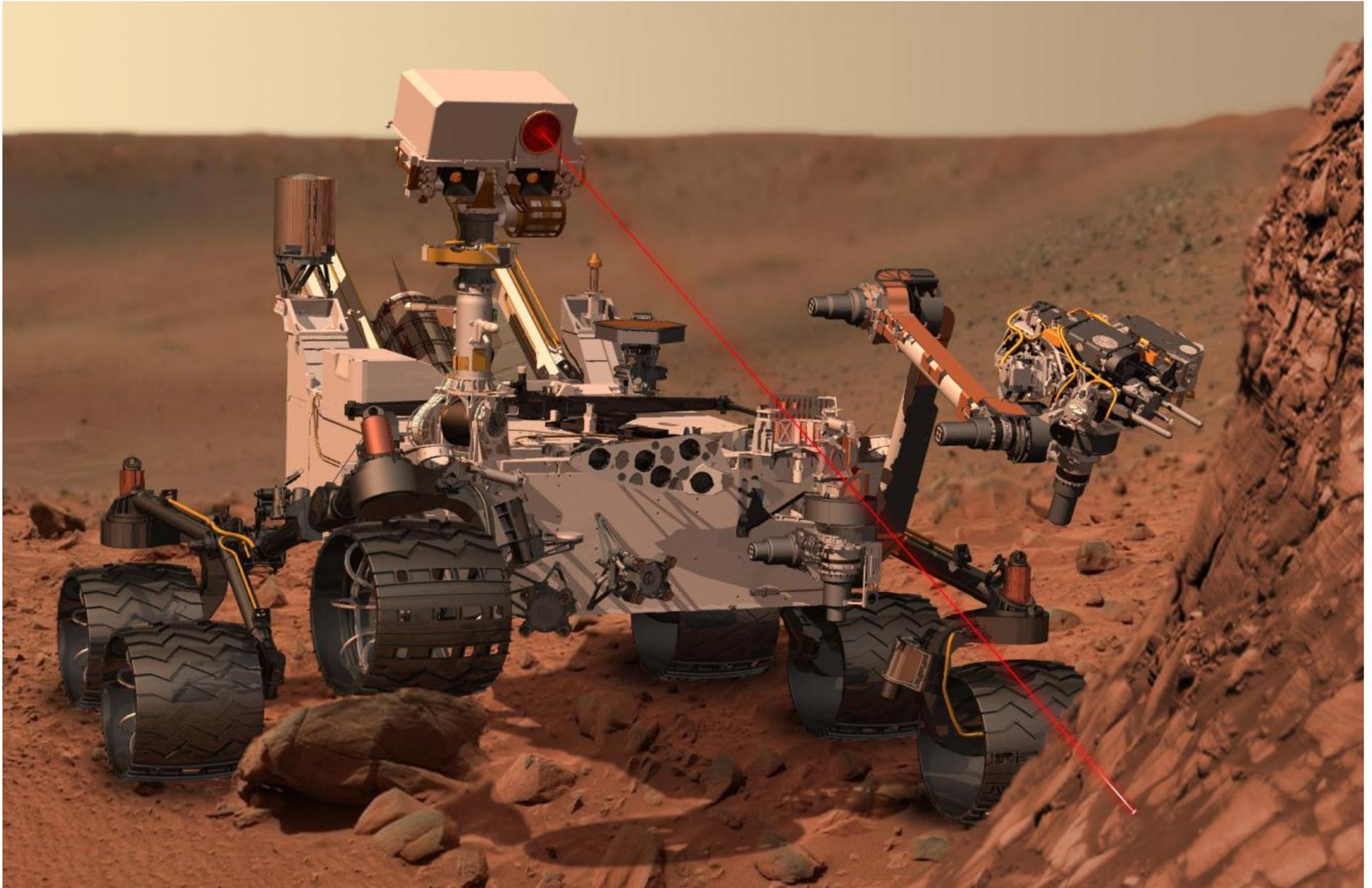


# Aeolis Mons (“Mt. Sharp”)

*Eroded Sedimentary Layers*



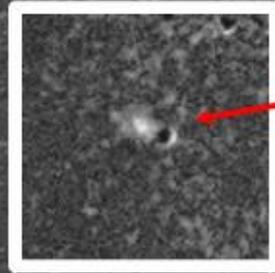
# Chemistry Camera (ChemCam)



# ChemCam

**Investigation**

*Square is 8 mm*

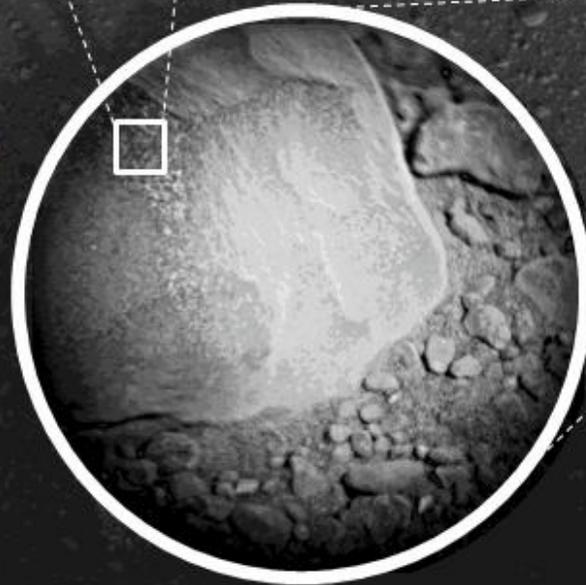


**Laser spot**

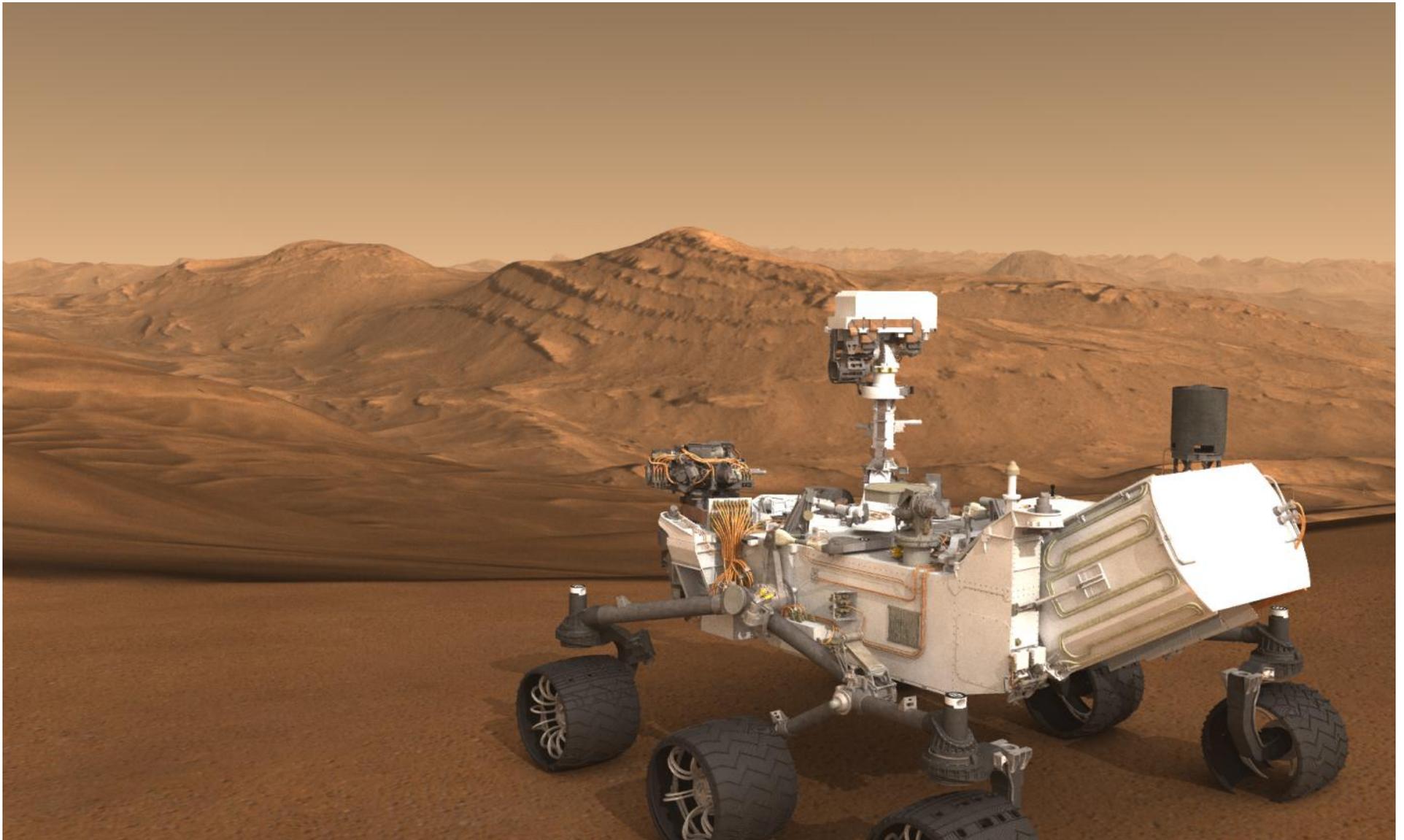


**ChemCam image**

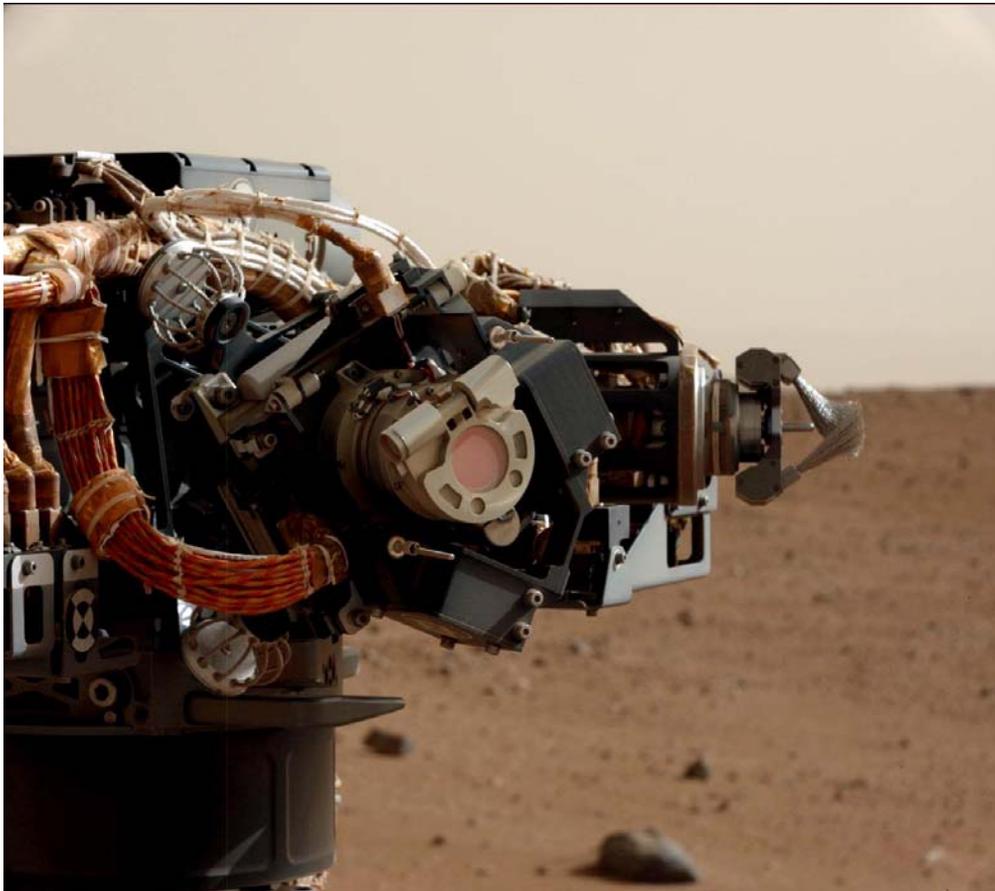
*Circle is 6 cm*



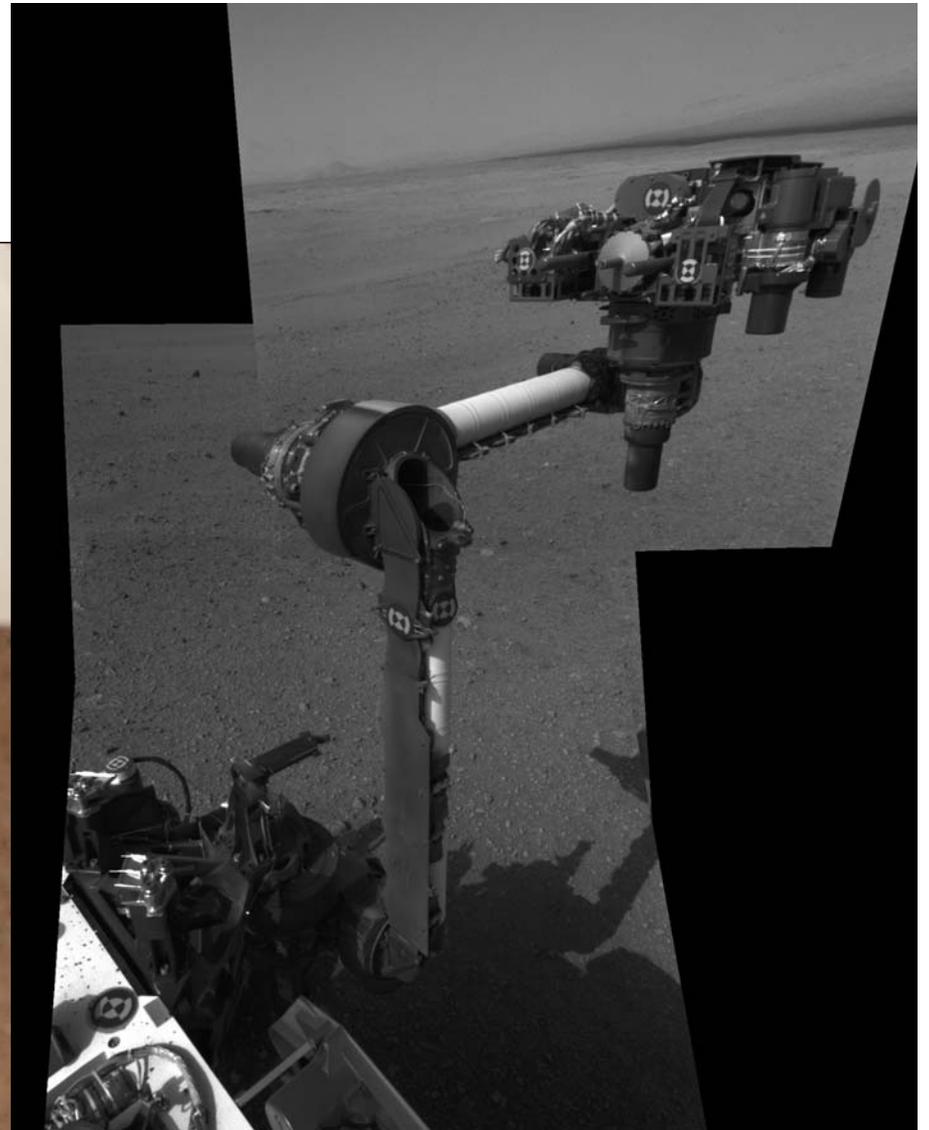
**Beyond signs of water, the rover will look for evidence of organics, the chemical building blocks of life.**



# MSL Robotic Arm (5-DOF)

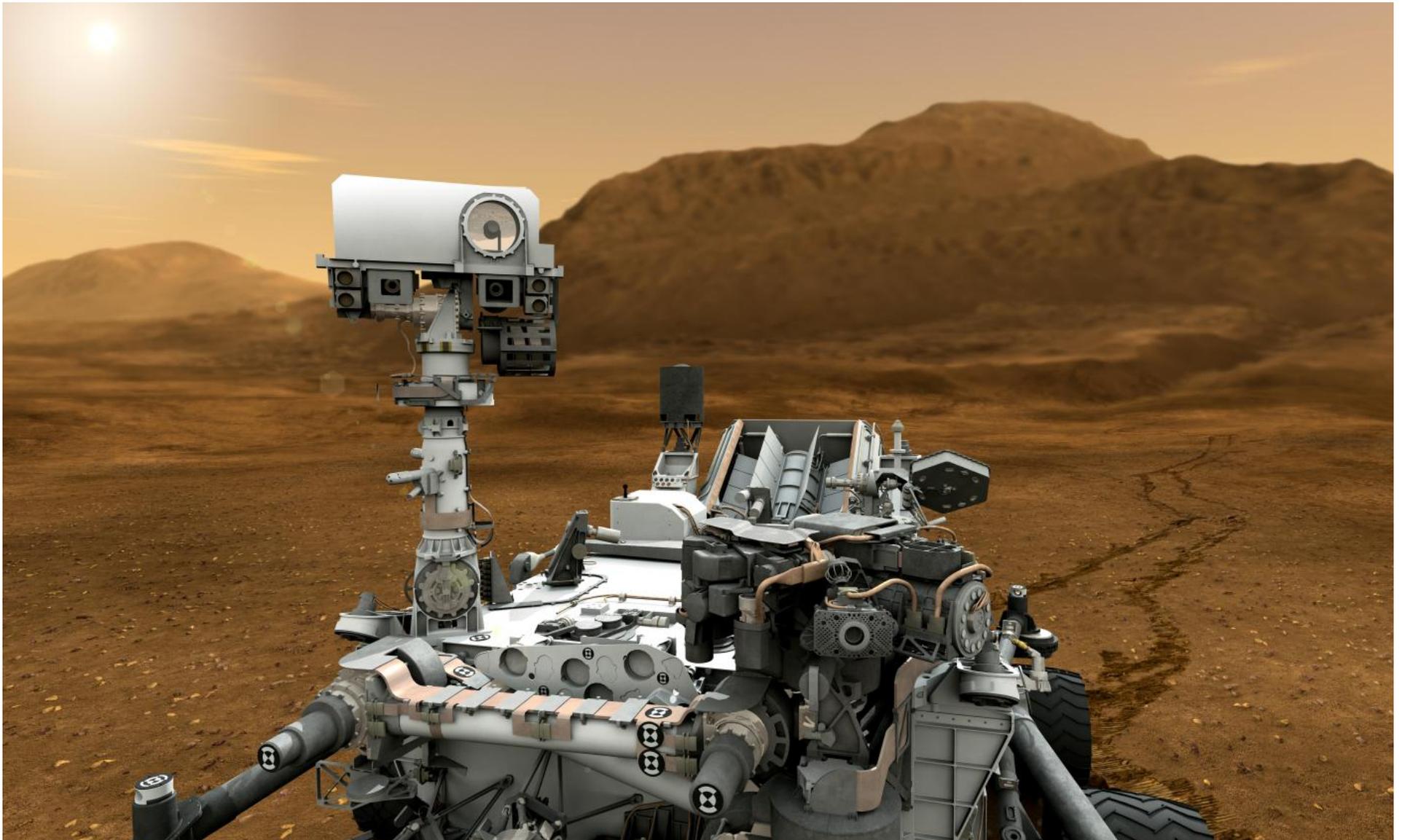


Mars Hand Lens Imager (MAHLI)



Alpha Particle X-Ray  
Spectrometer (APXS)

**Curiosity is expected to operate for one Martian year, or about two Earth years.**



**You are here**



*Earth as seen from Mars*



***Thank You!***

***Daybreak at Gale Crater***

## For Your Reference

- **7 Minutes of Terror**

<http://www.jpl.nasa.gov/video/index.php?id=1090>

- **NASA/JPL – Mars Science Laboratory**

<http://mars.jpl.nasa.gov/msl/>

- **NASA/HQ – Mars Science Laboratory**

[http://www.nasa.gov/mission\\_pages/msl/index.html](http://www.nasa.gov/mission_pages/msl/index.html)

- **Be A Martian!**

<http://beamartian.jpl.nasa.gov/welcome>





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***November 1, 2012***