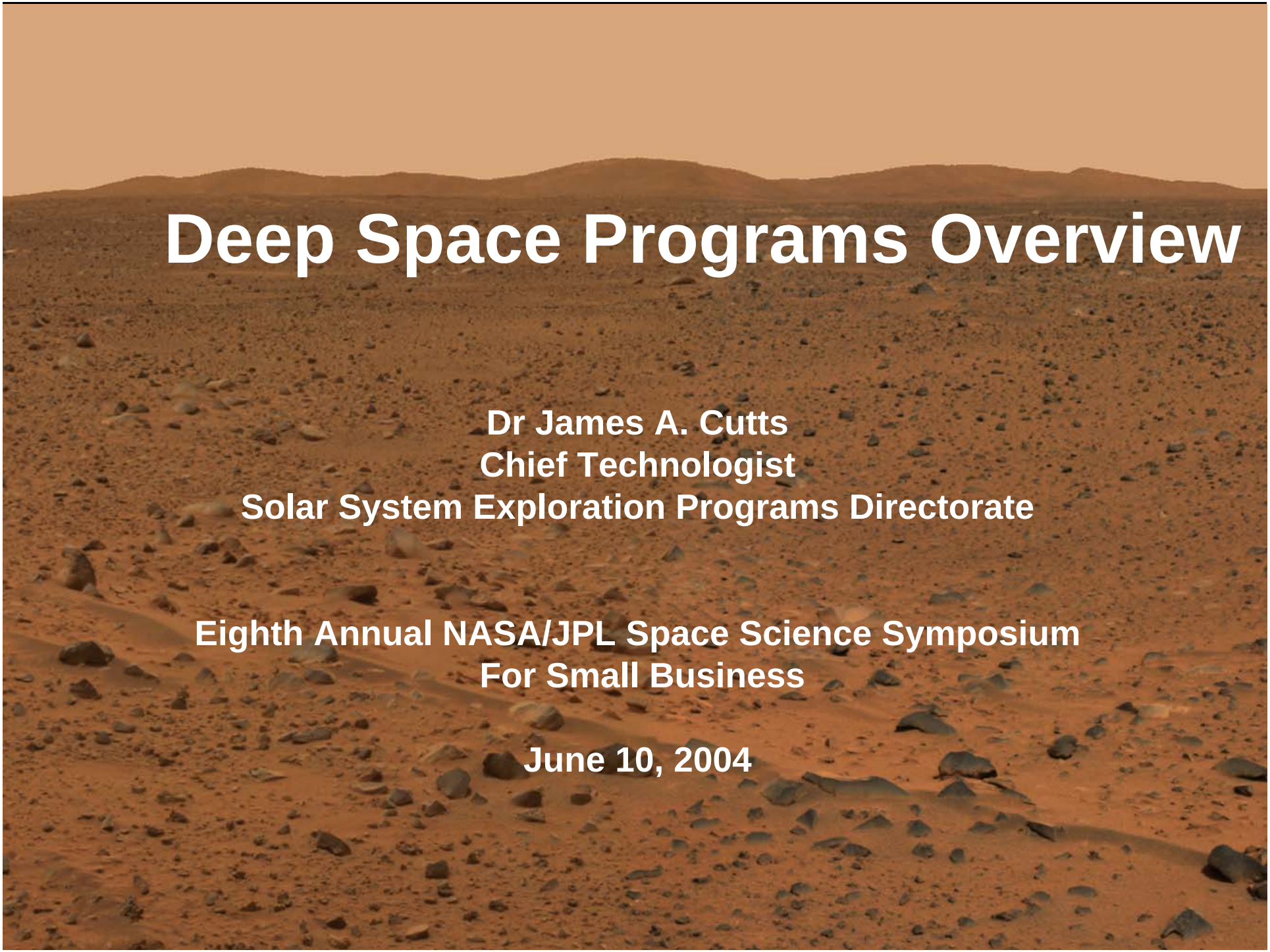


Deep Space Programs Overview

Dr James A. Cutts
Chief Technologist
Solar System Exploration Programs Directorate

Eighth Annual NASA/JPL Space Science Symposium
For Small Business

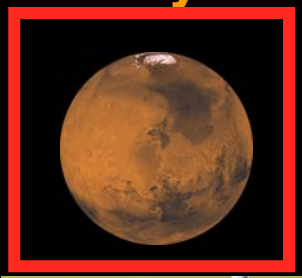
June 10, 2004

Topics

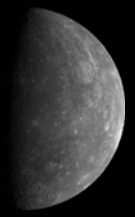
- Overview
- Mars Exploration
- Outer Planet Exploration
- How to contact us

Our Solar System: Forty Years of Exploration

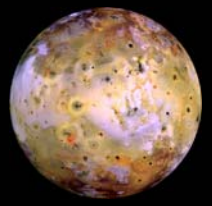
Asteroids

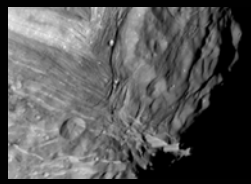


Terrestrial Planets

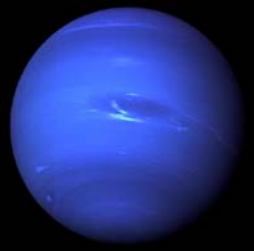


Comets

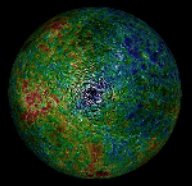


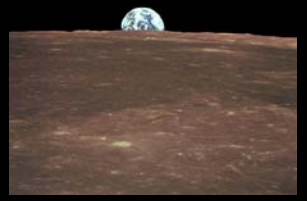


Planetary Satellites

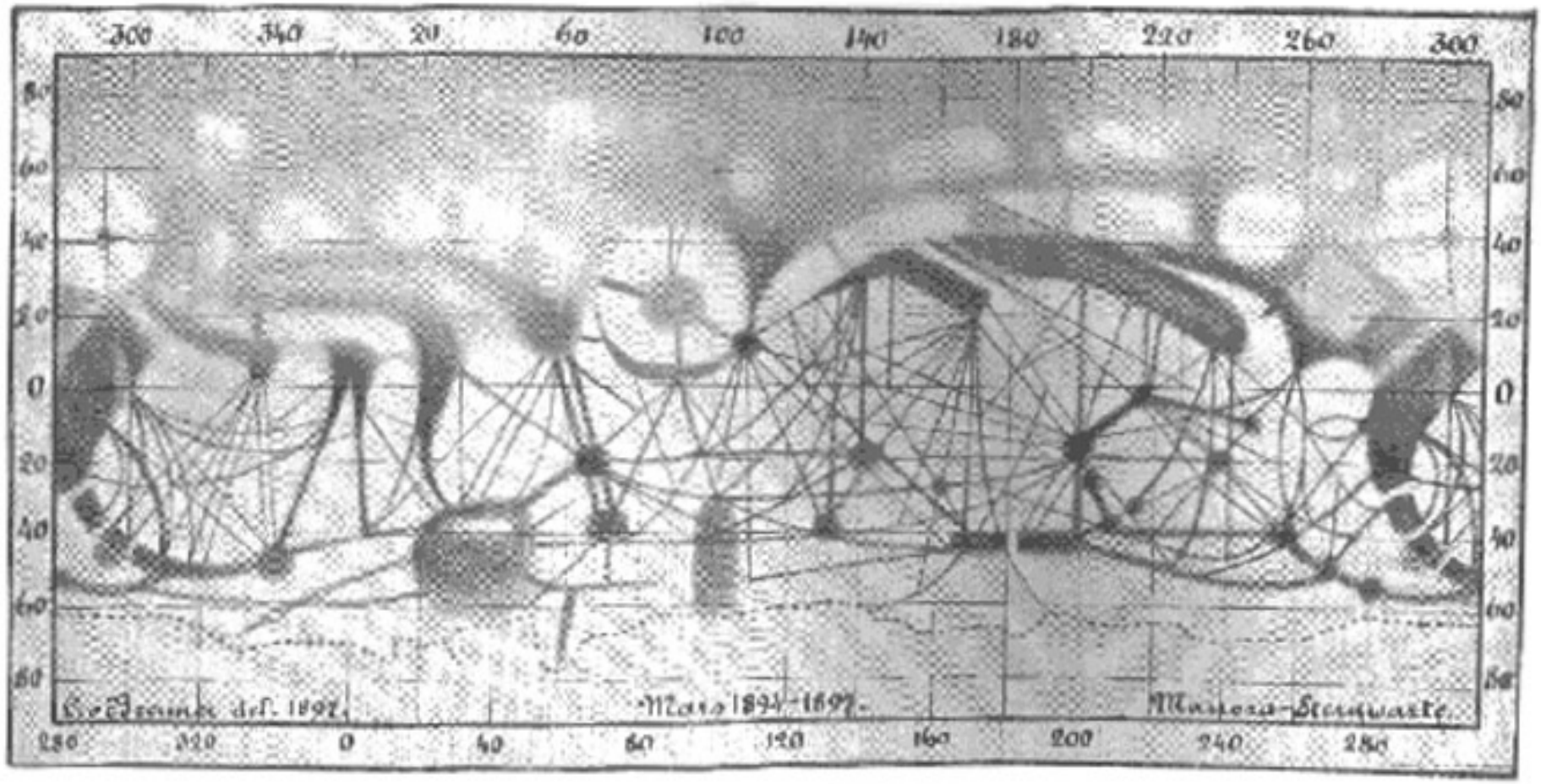


Giant Planets

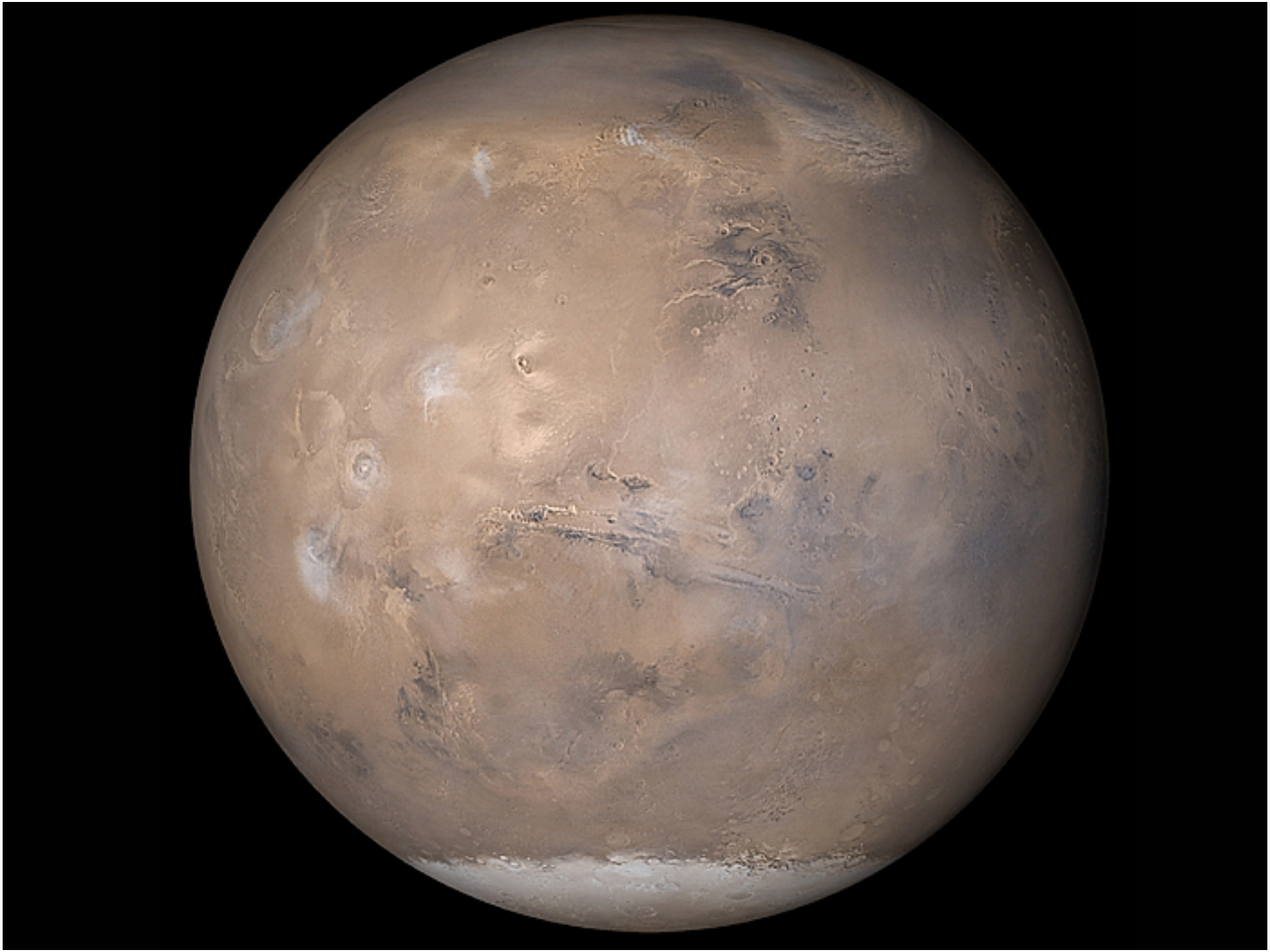




The Moon

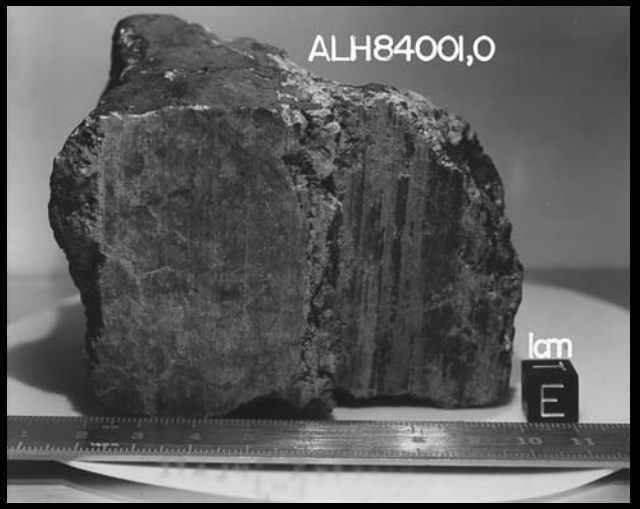


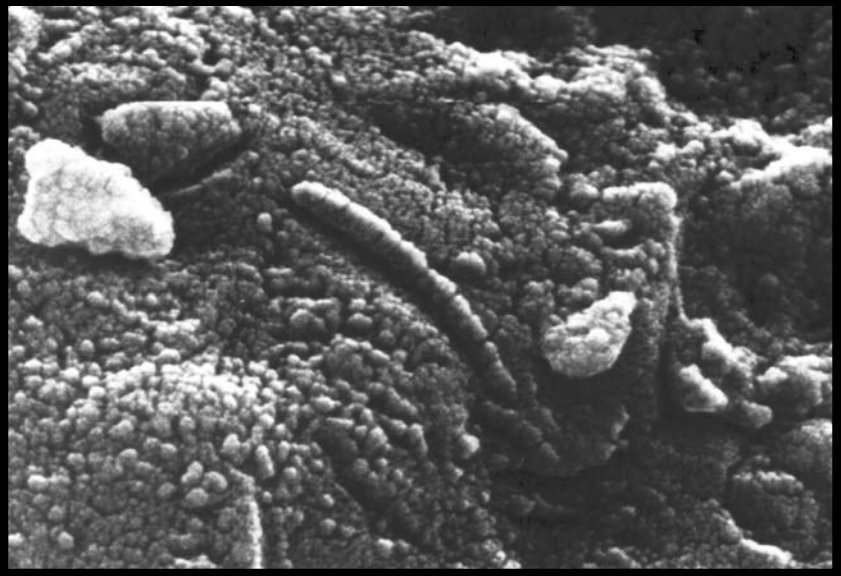
Mars Exploration 1900

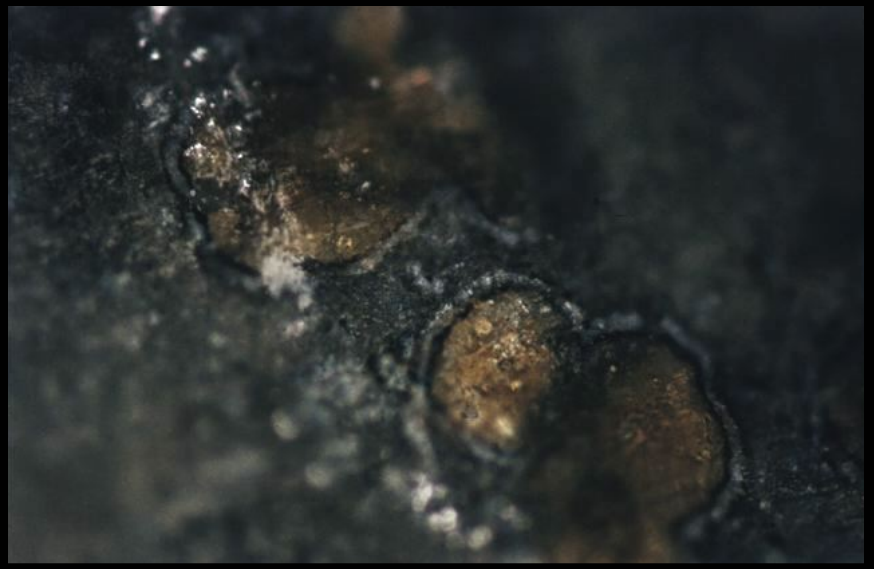


Life on Mars?

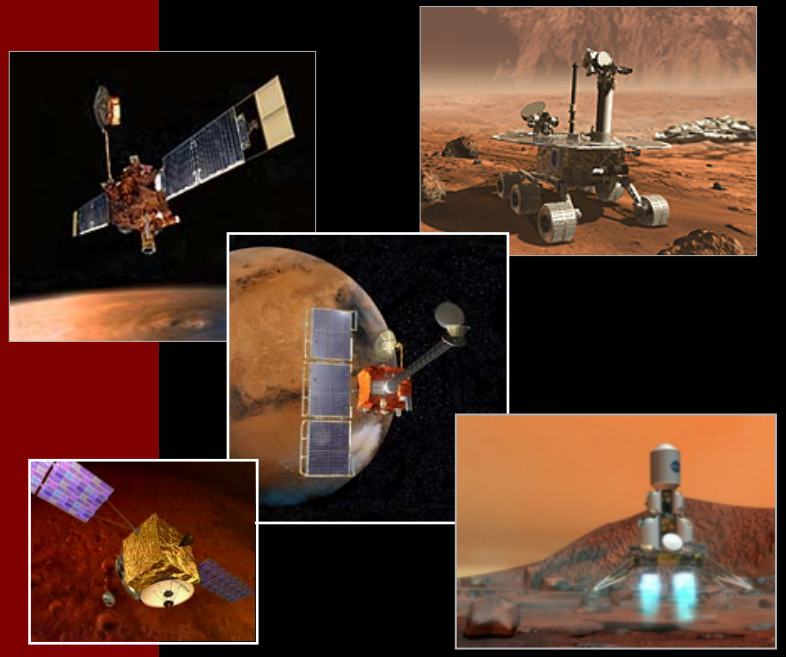
Was Evidence of Life Found in Martian Meteorite?







Mars Exploration Program



A science-driven, technology enabled effort to characterize and understand Mars, including its current environment, climate, and geological history and biological potential

Central among the questions to be asked is… "Did life ever arise on Mars?"

The science strategy is known as "Follow the Water."

The exploration approach is "Seek, In-Situ, Sample."

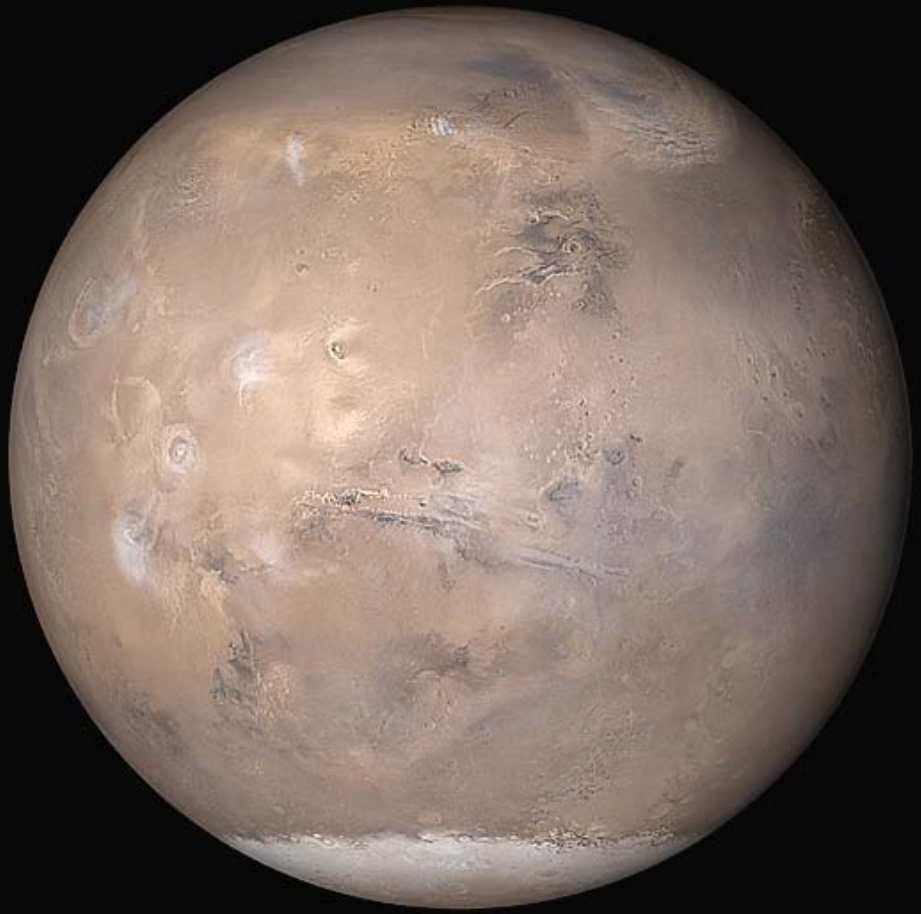

Was Mars once a habitat
for microbial life?
Was Mars once wet?

Gully Systems

Crater Wall Gullies, Gorgonum Basin
39.1°S, 166.1°W

Crater Wall Gullies, Newton Basin
42.6°S, 158.1°W

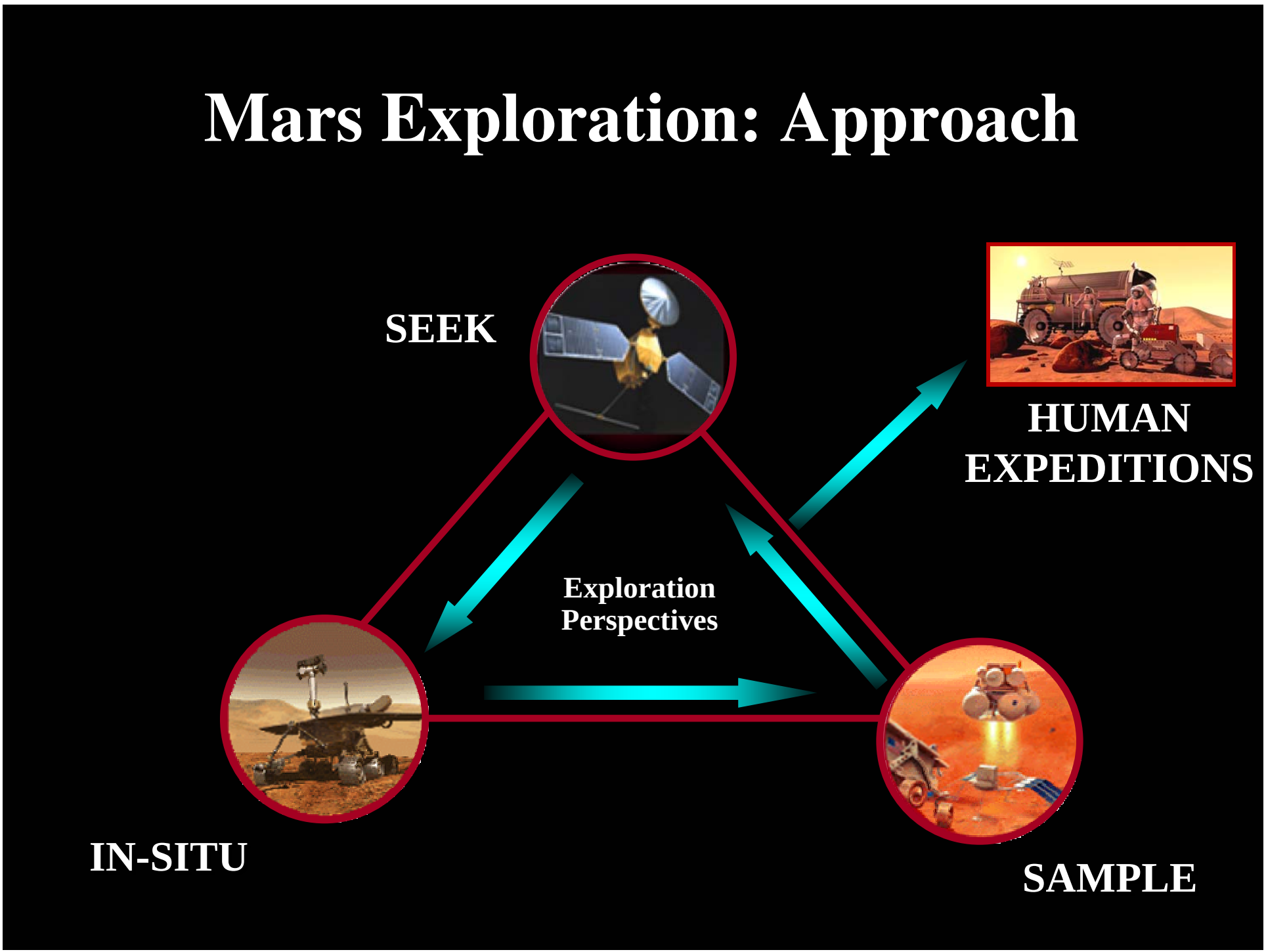
Ancient Mars?



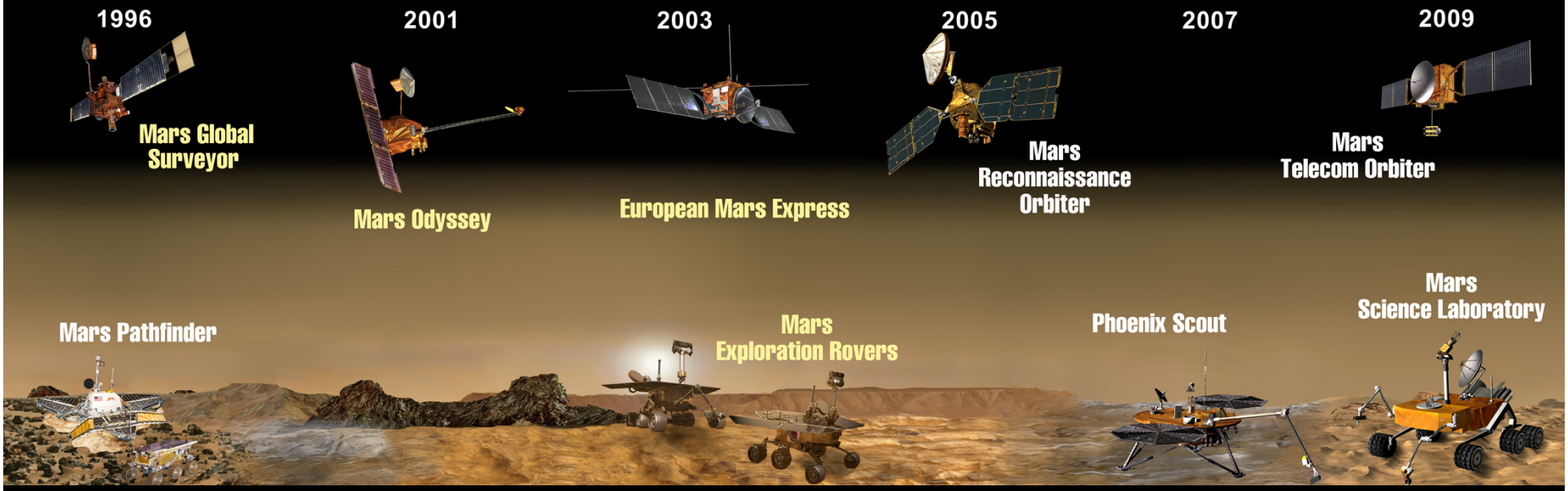
Modern
Cold and Arid

Past?
Wet and Warm?

Mars Exploration: Approach



Mars Exploration Program
1996 - 2009



Mars Exploration Rover

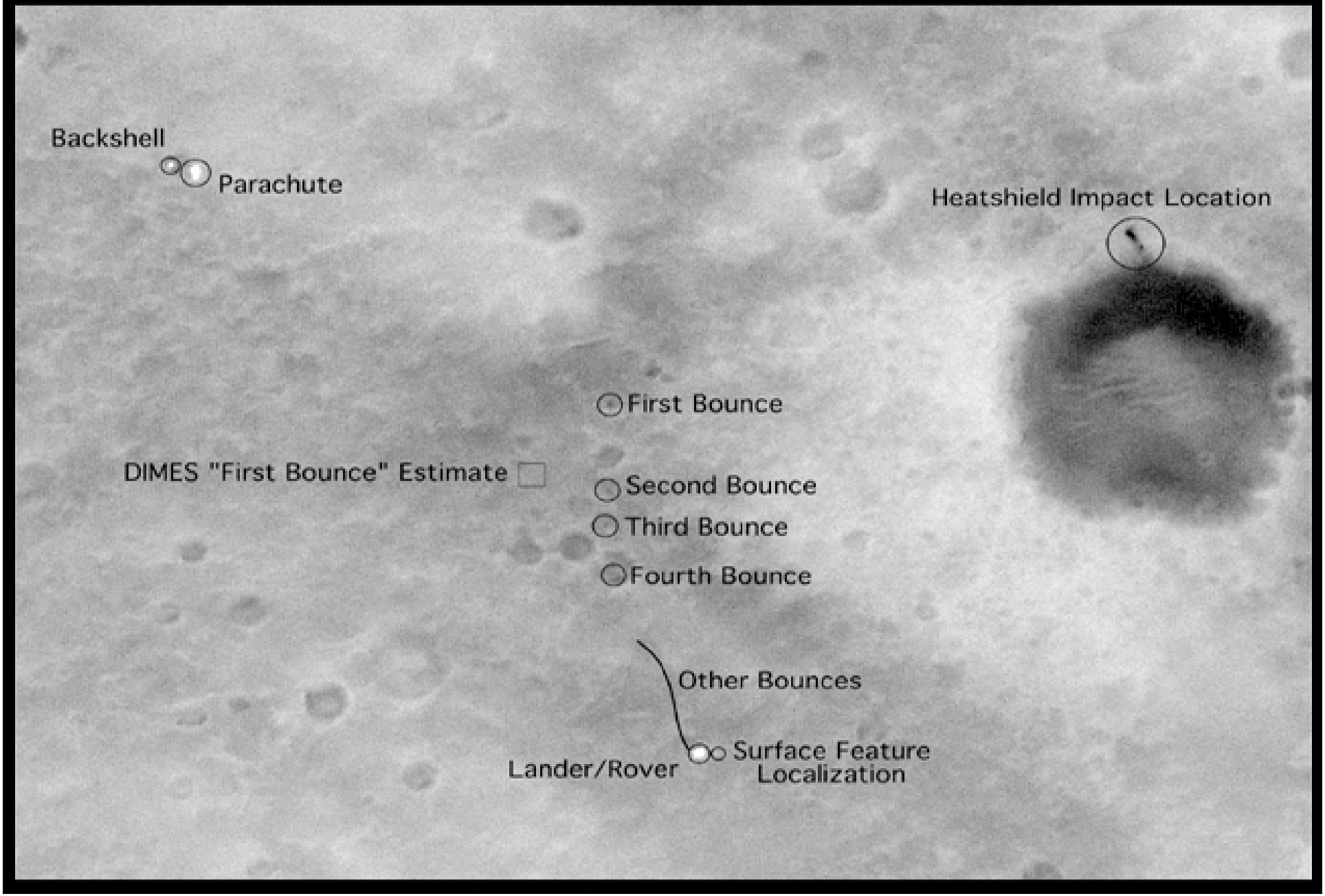
Gusev Crater

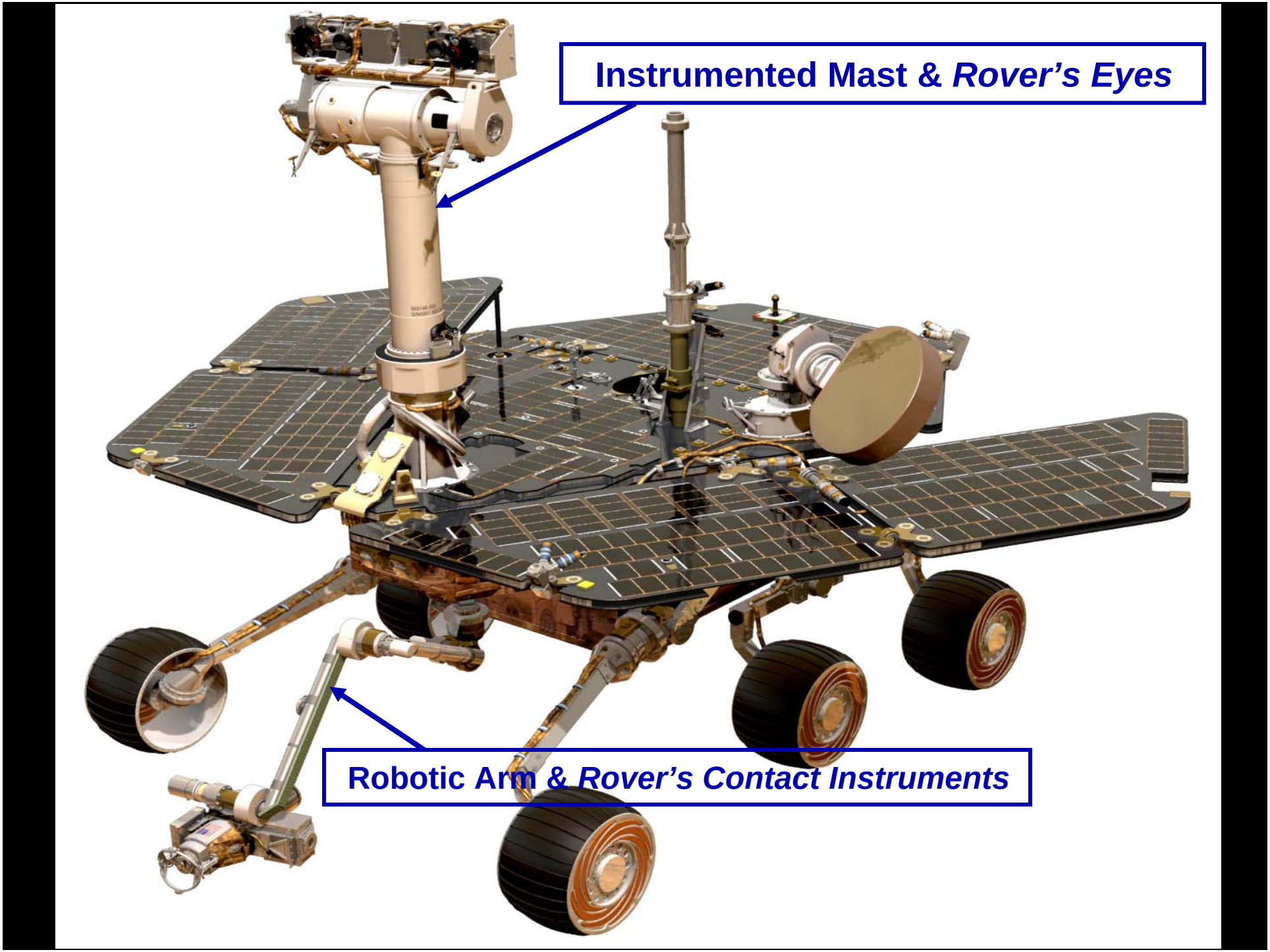
Landing Site for *Spirit*

Crater diameter: 150 km (93 miles)

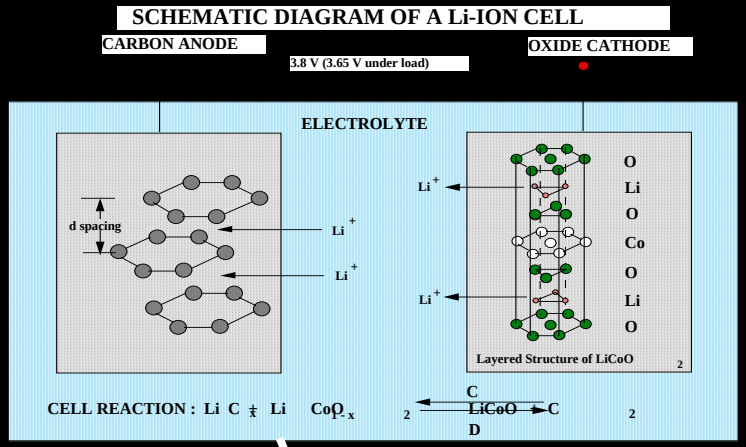
Spirit rover installed inside the aeroshell

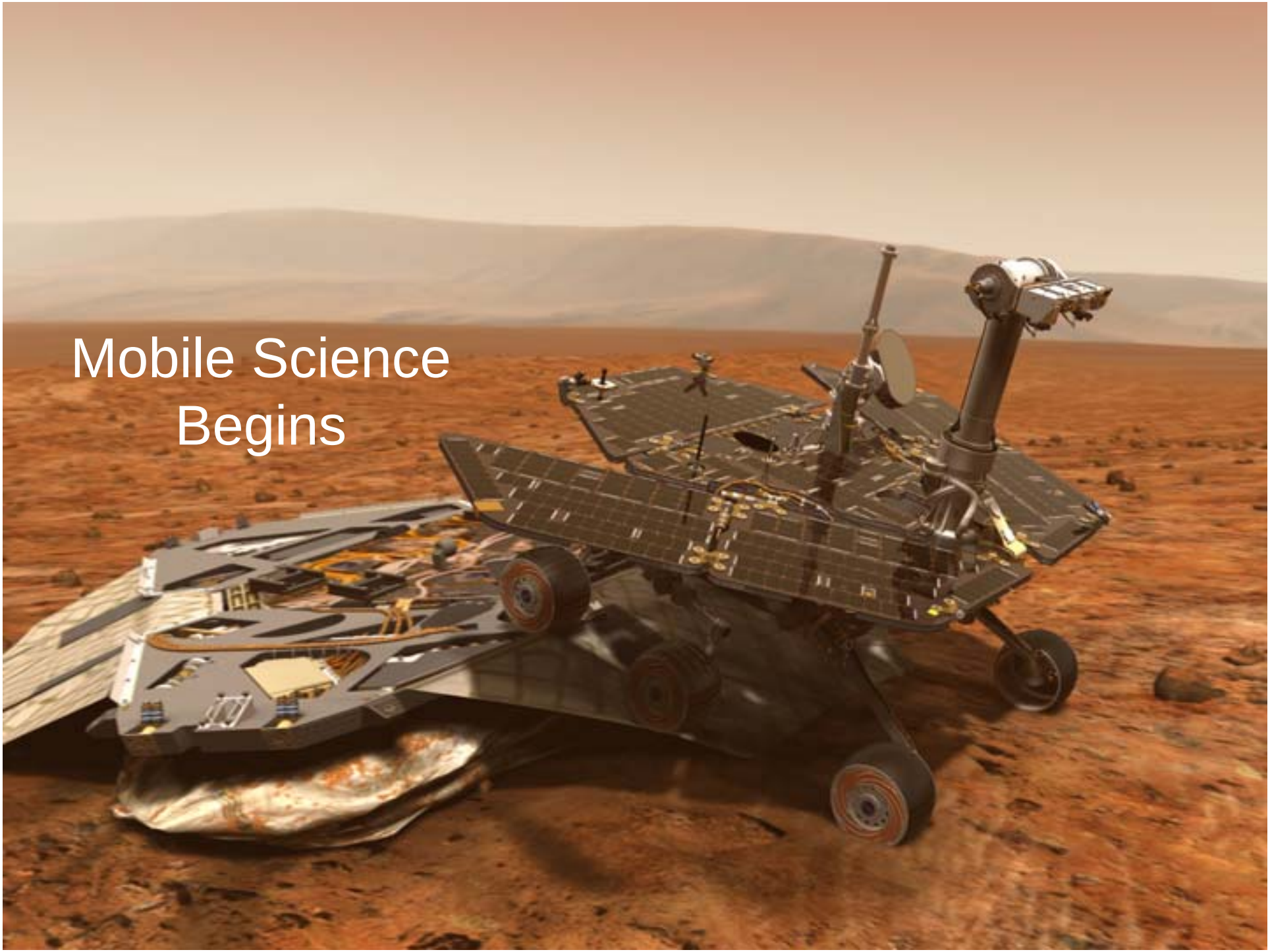
Spirit Landing Site at Gusev Crater

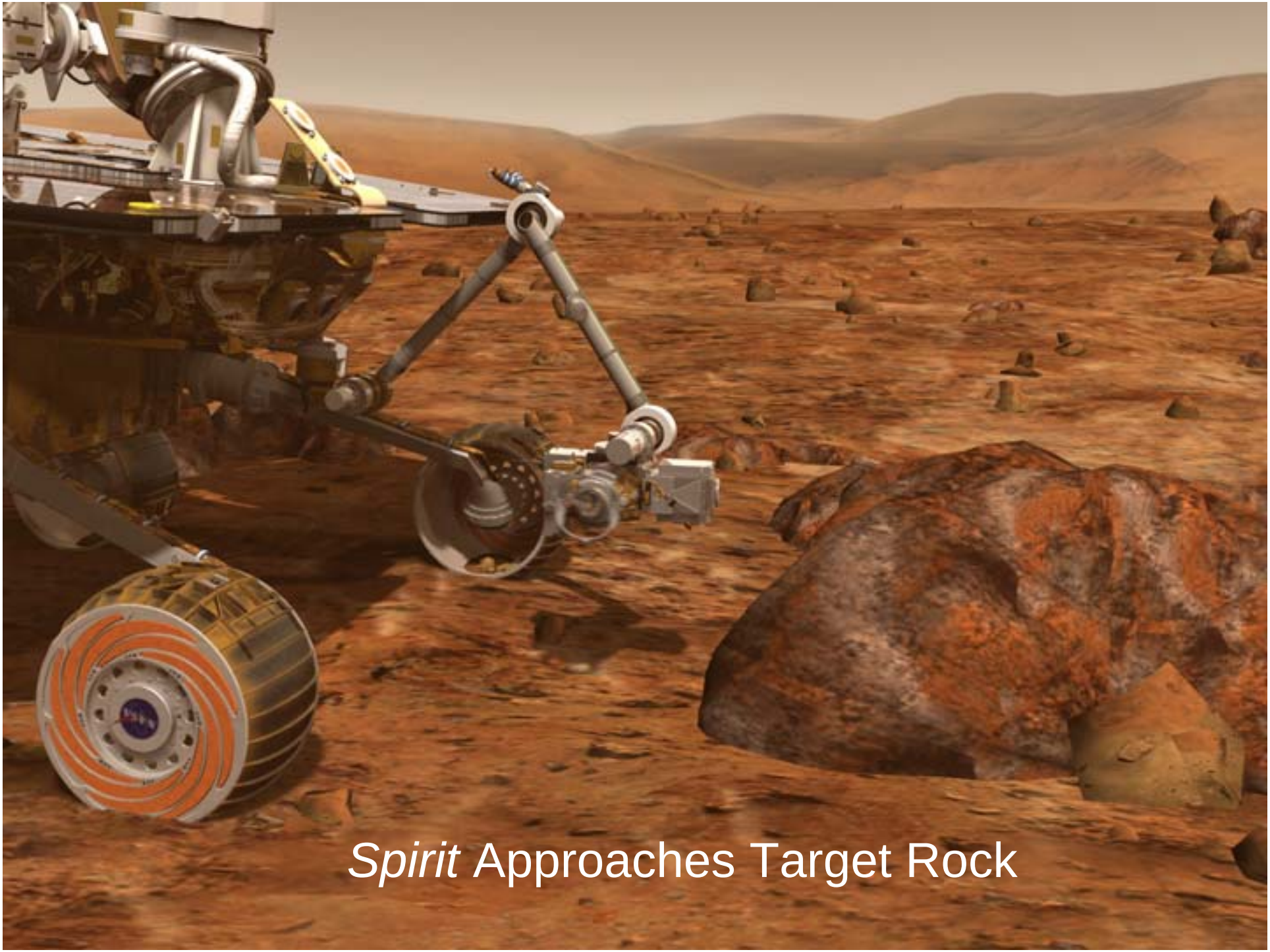



Instrumented Mast & *Rover's Eyes*
Robotic Arm & *Rover's Contact Instruments*

JPL Partnership with Small Business Provides Power to Spirit and Opportunity

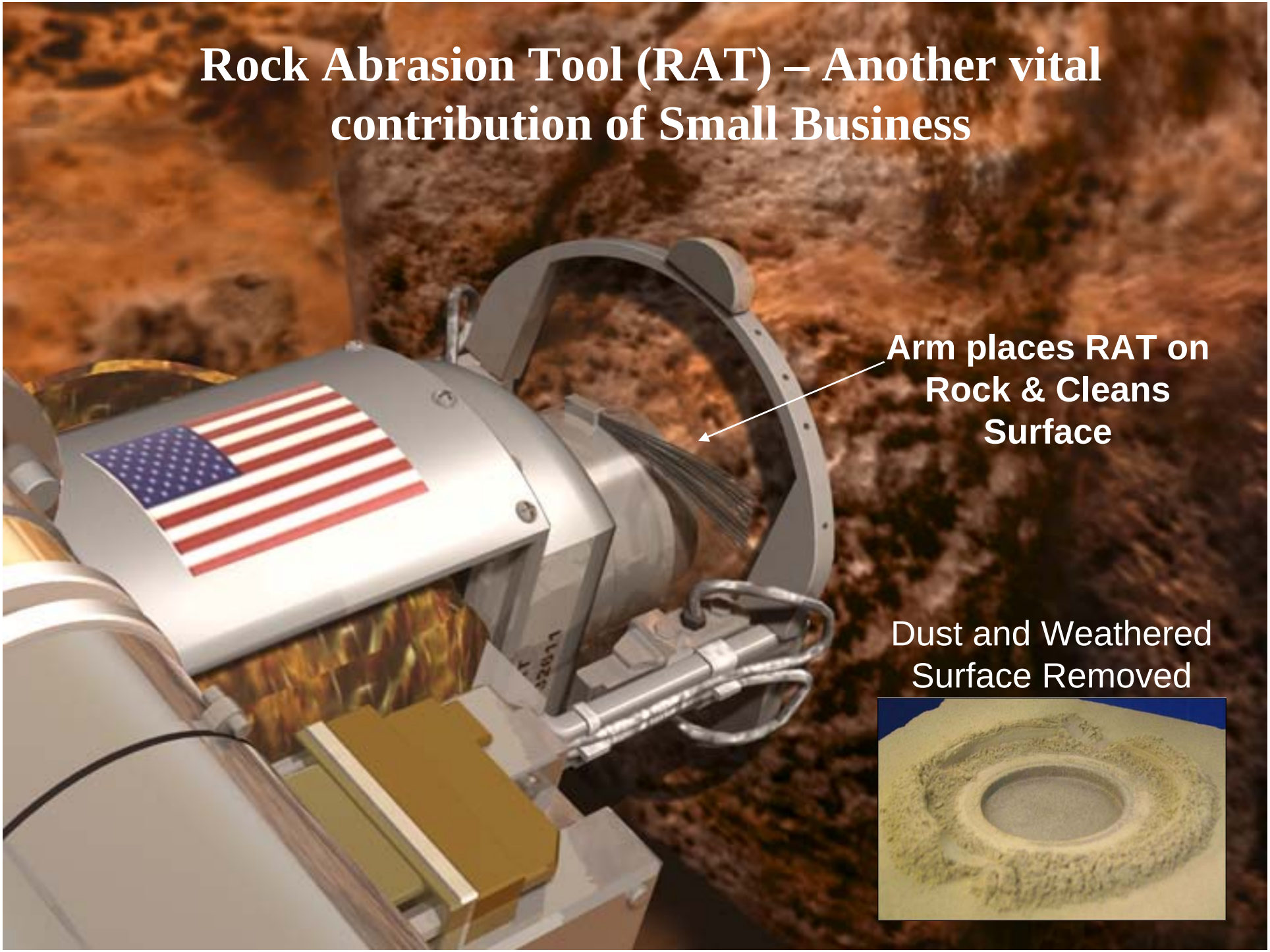


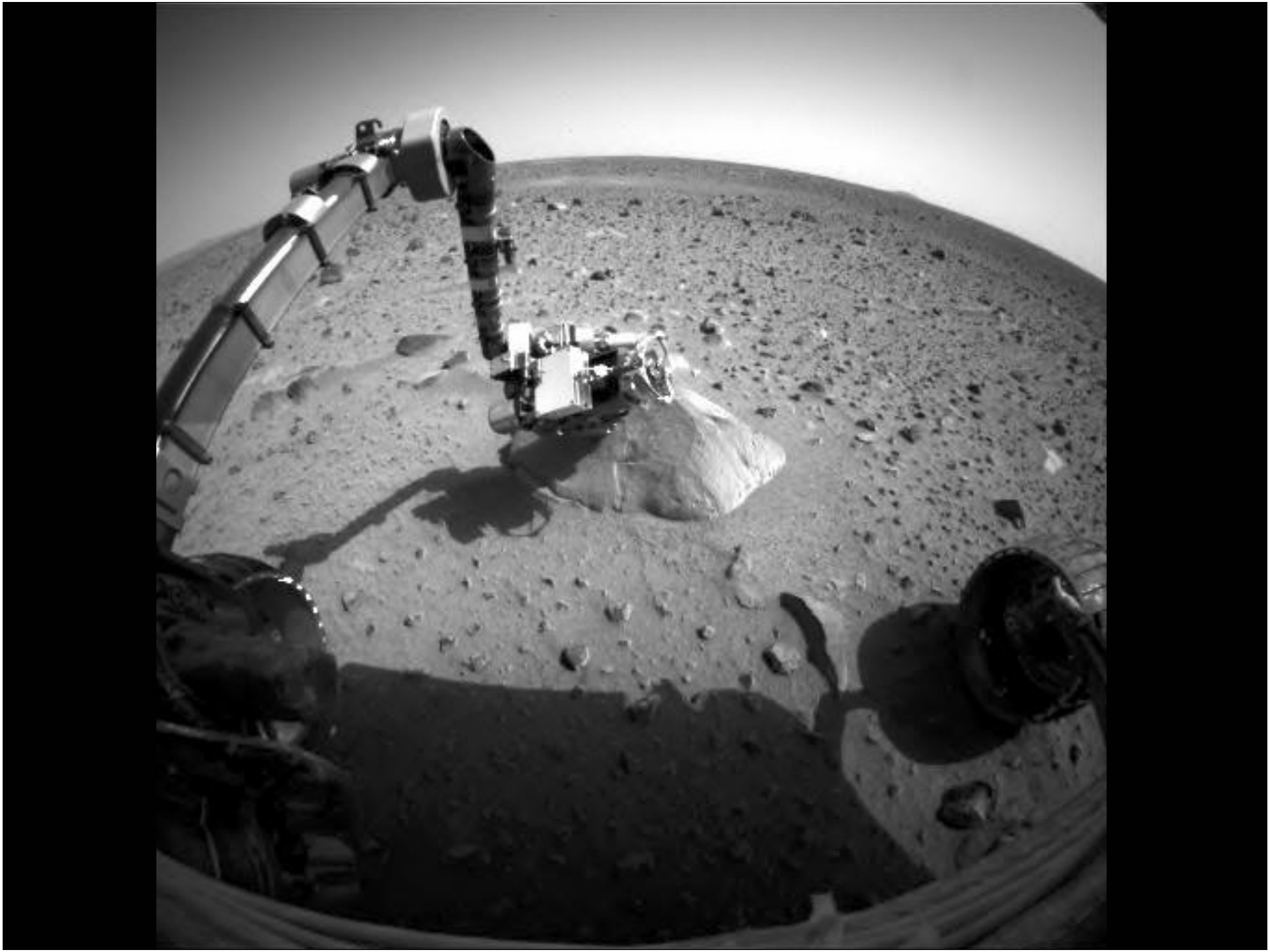

Mobile Science
Begins

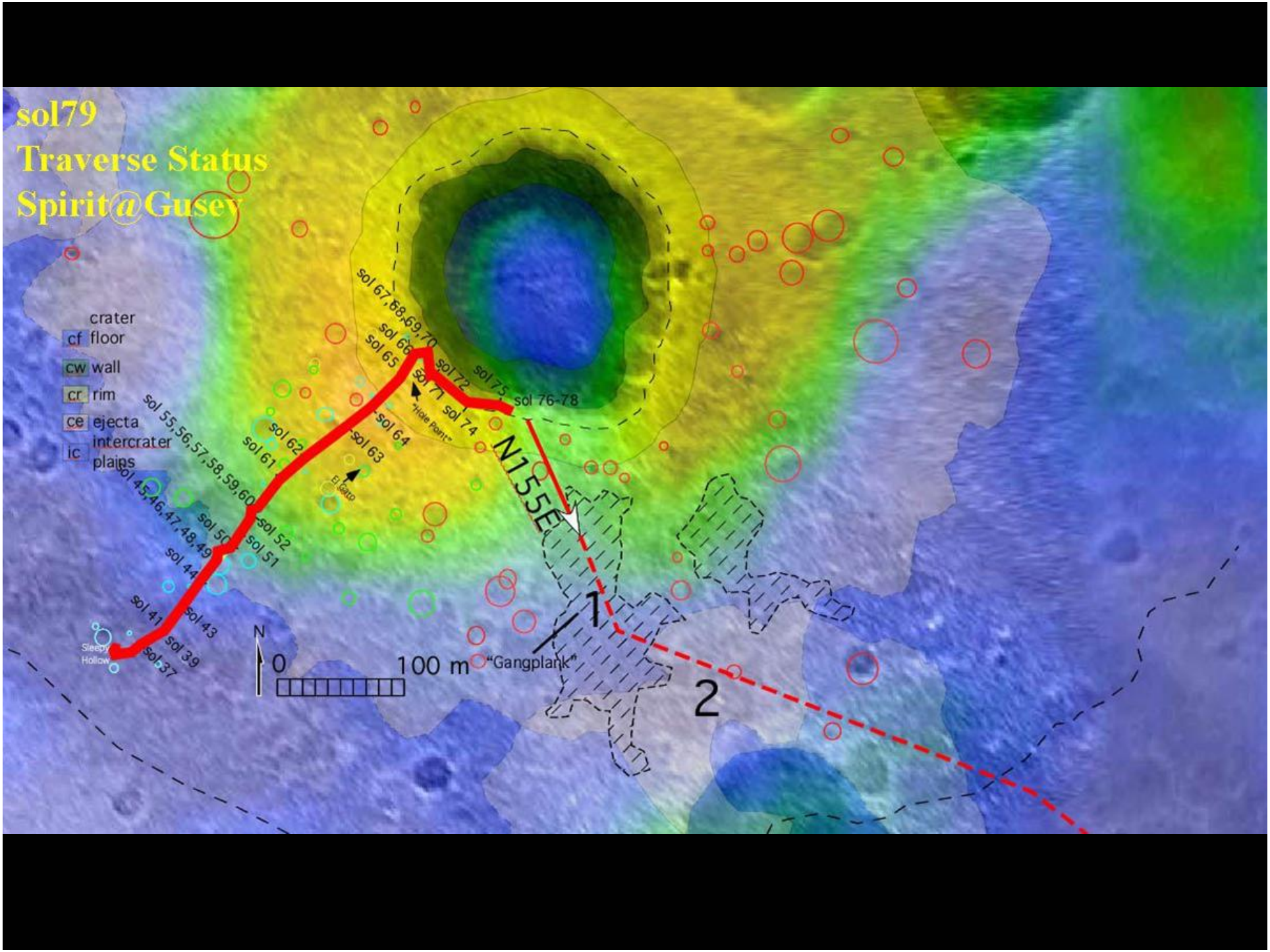


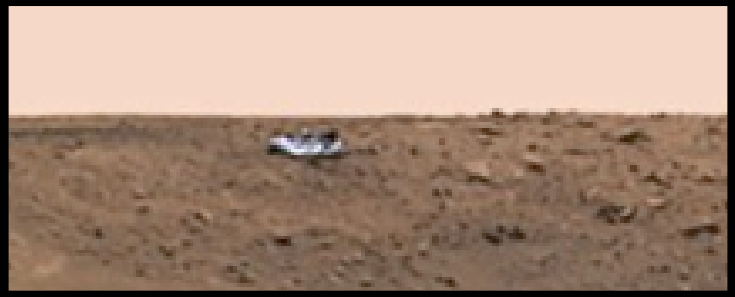
Spirit Approaches Target Rock

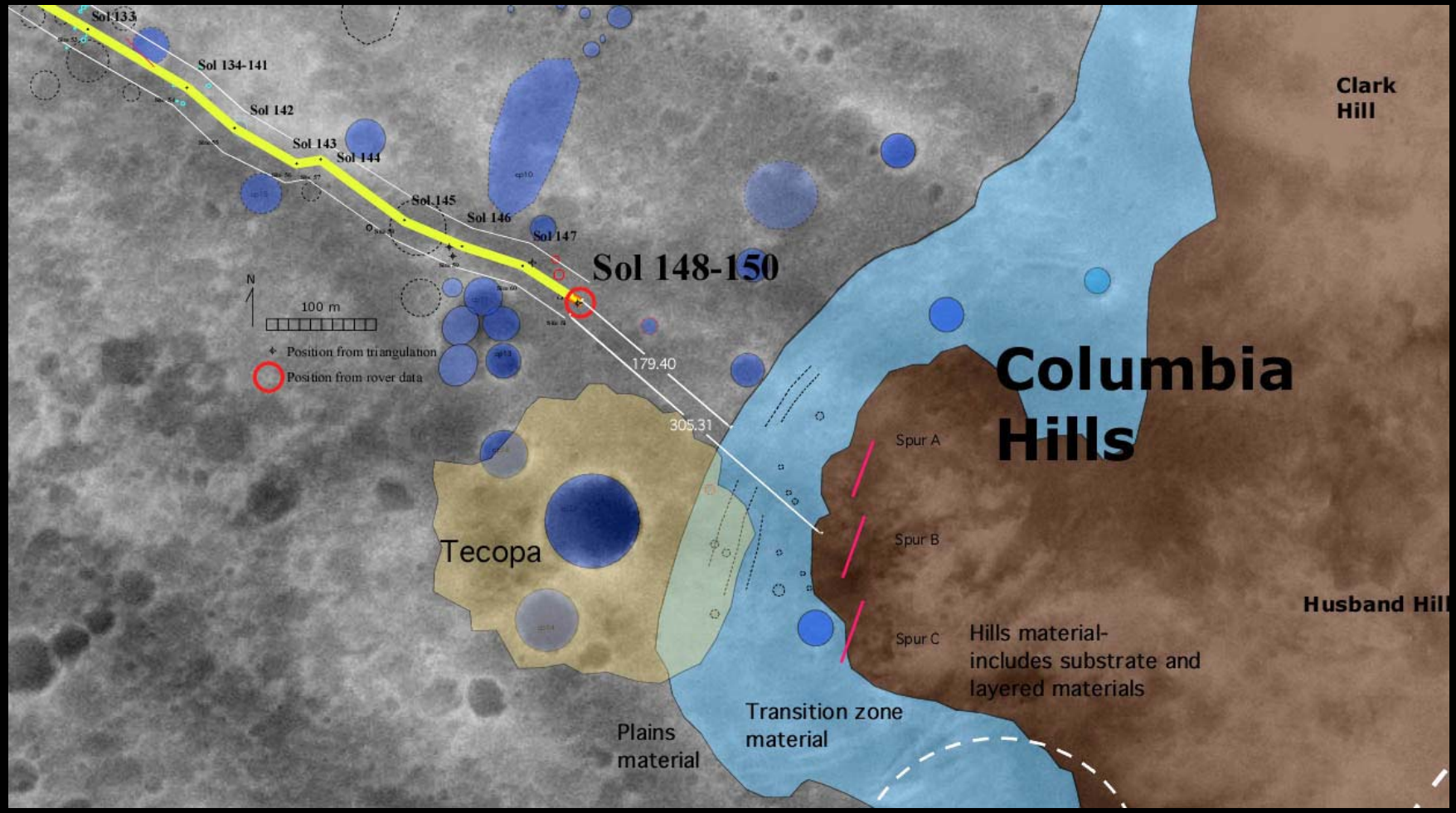
Rock Abrasion Tool (RAT) – Another vital contribution of Small Business






sol79
Traverse Status
Spirit@Gusev
crater
cf floor
cw wall
cr rim
ce ejecta
ic intercrater plains
sol 45,46,47,48,49
sol 50
sol 51
sol 52
sol 55,56,57,58,59,60
sol 61
sol 62
sol 63
sol 64
sol 65
sol 66
sol 67,68,69,70
sol 71
sol 72
sol 74
sol 75
sol 76-78
"Hole Point"
El Gato
N155E
sol 41
sol 43
sol 44
sol 39
sol 37
Sleepy Hollow
N
0
100 m
"Gangplank"
1
2




Sol 133
Sol 134-141
Sol 142
Sol 143
Sol 144
Sol 145
Sol 146
Sol 147
Sol 148-150
N
100 m
Position from triangulation
Position from rover data
179.40
305.31
Clark Hill
Columbia Hills
Spur A
Spur B
Spur C
Husband Hill
Tecopa
Hills material- includes substrate and layered materials
Transition zone material
Plains material

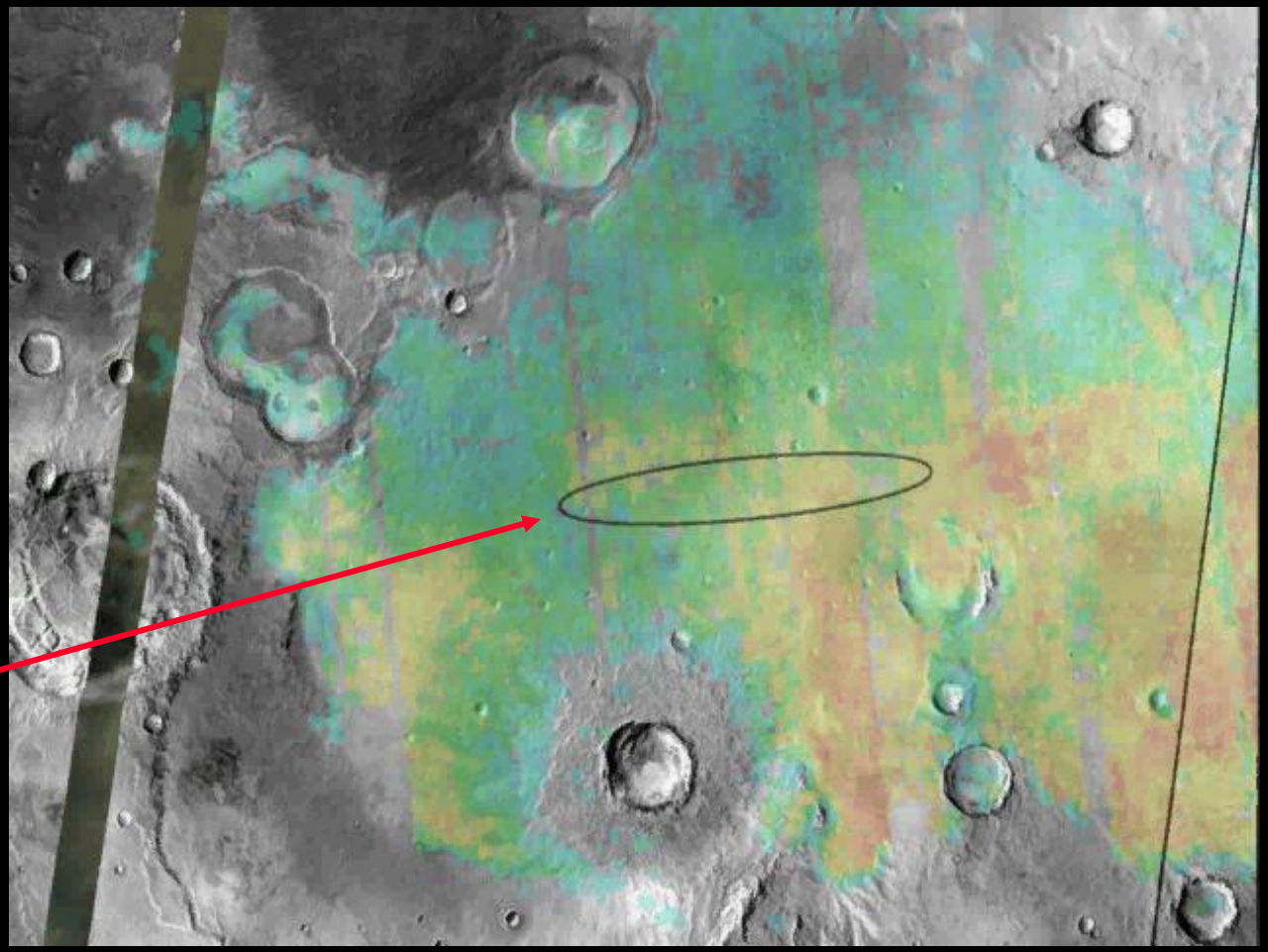
COLUMBIA HILLS - RIGHT AHEAD

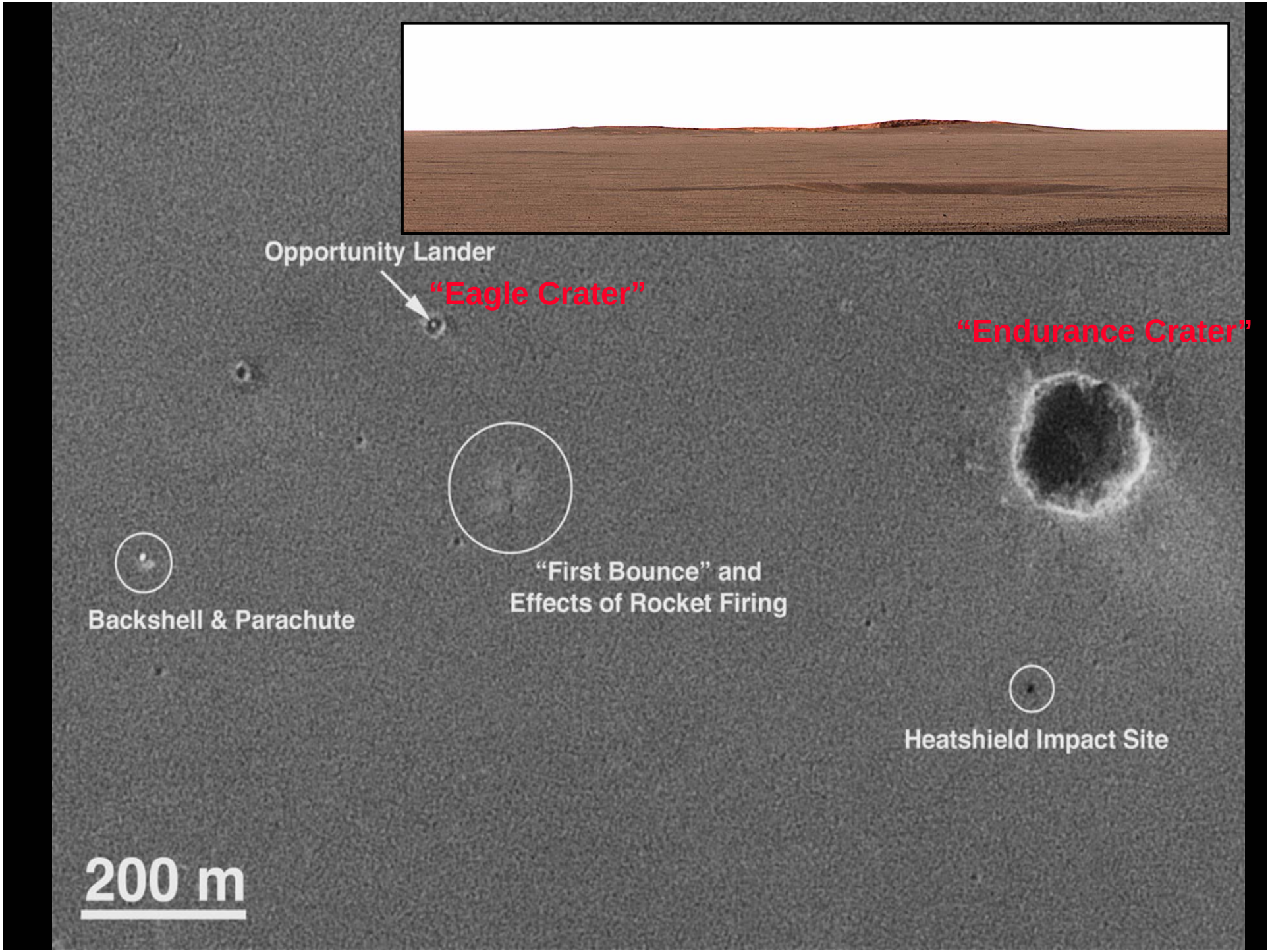
Meridiani Planum

Landing Site for *Opportunity*

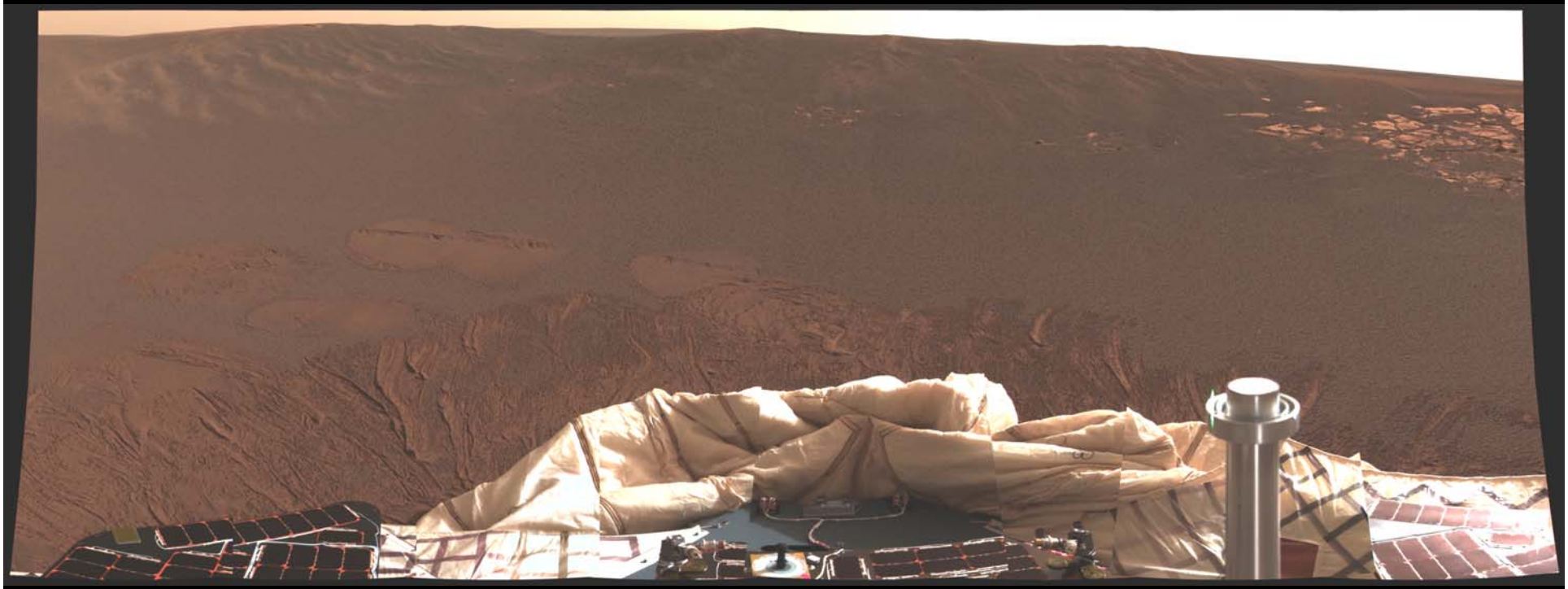
Gray crystalline hematite

Opportunity's 71 km x 9 km landing ellipse

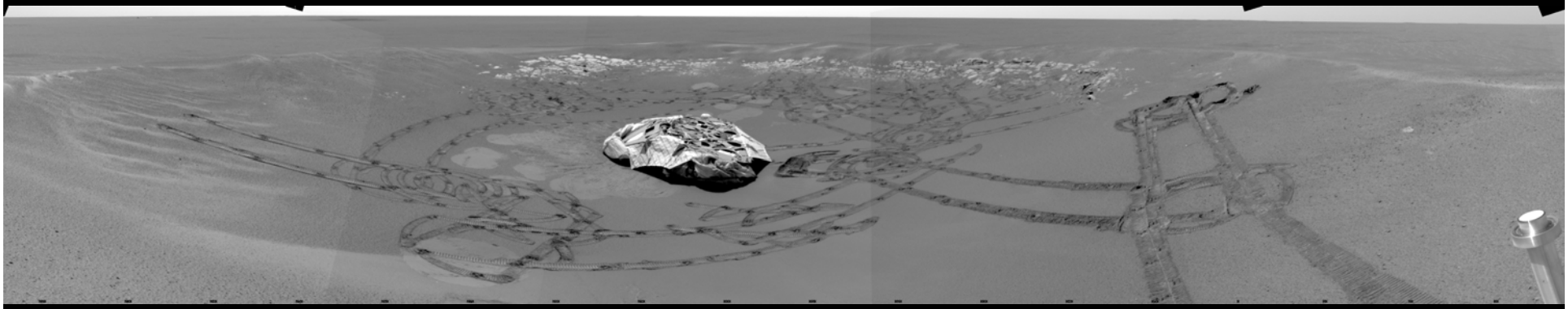



Opportunity Lander
"Eagle Crater"
"Endurance Crater"
"First Bounce" and
Effects of Rocket Firing
Backshell & Parachute
Heatshield Impact Site
200 m

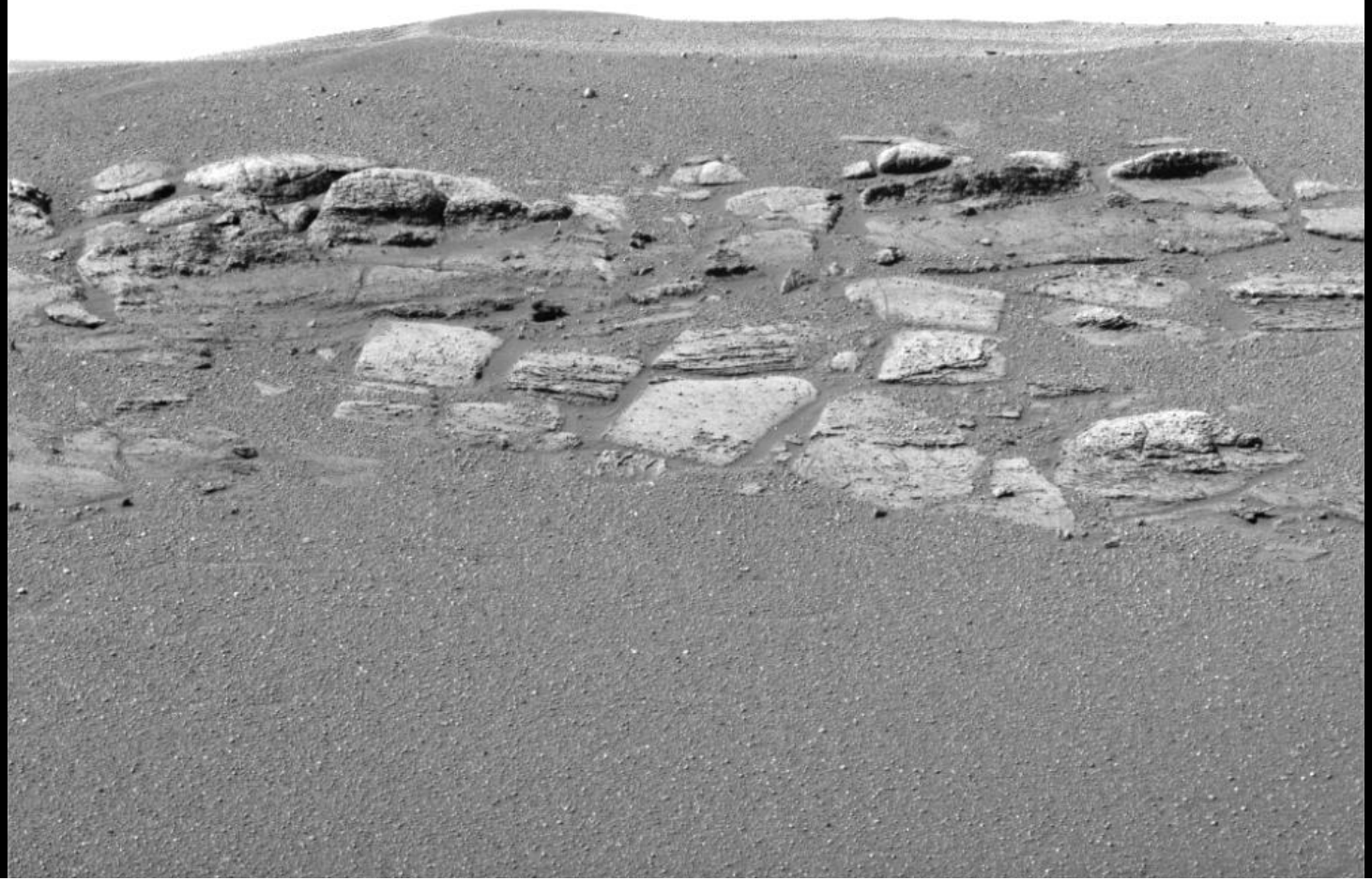
Opportunity at *Eagle* Crater

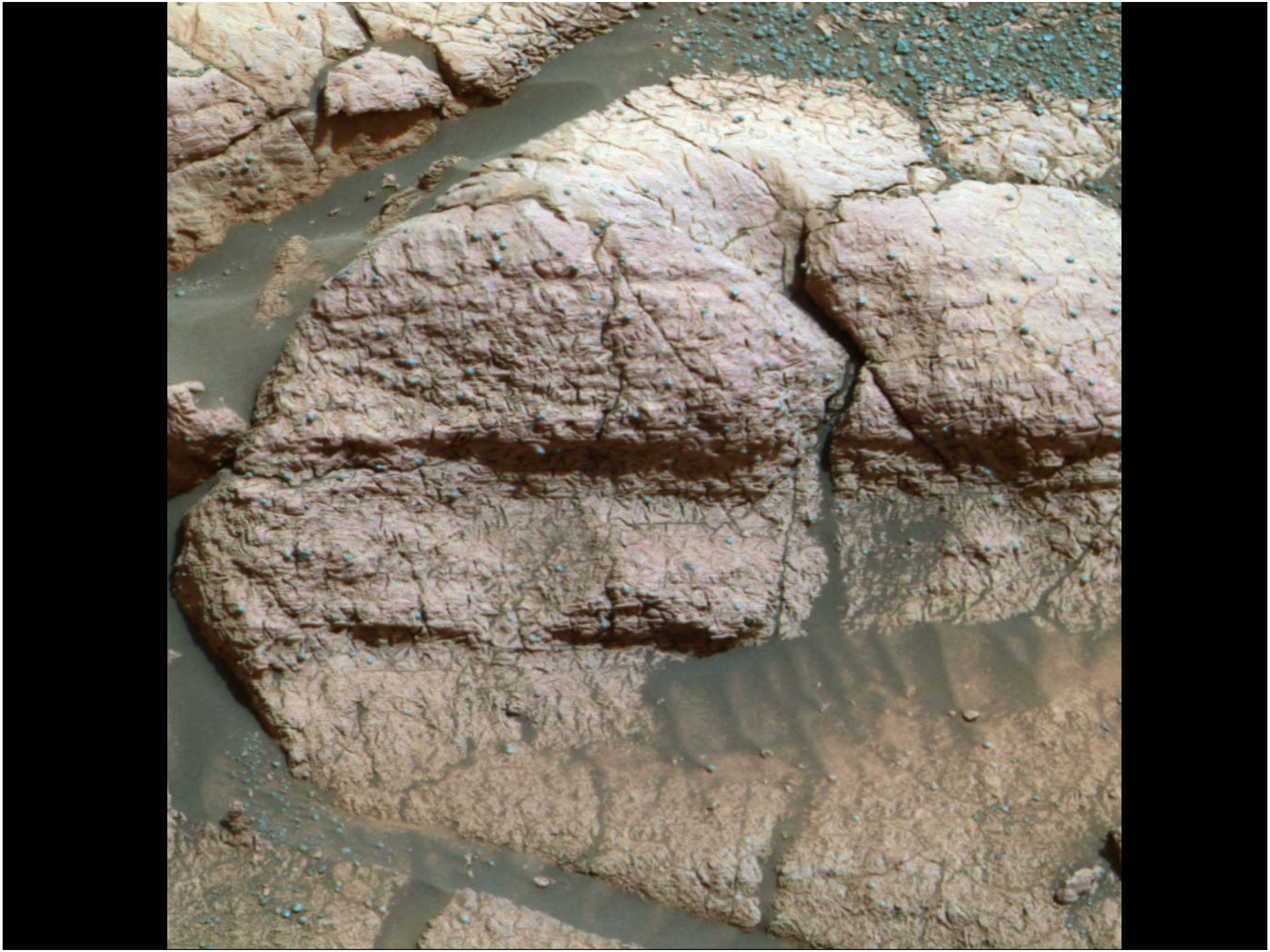


Opportunity Site
Lander Viewed from Rover in Eagle Crater

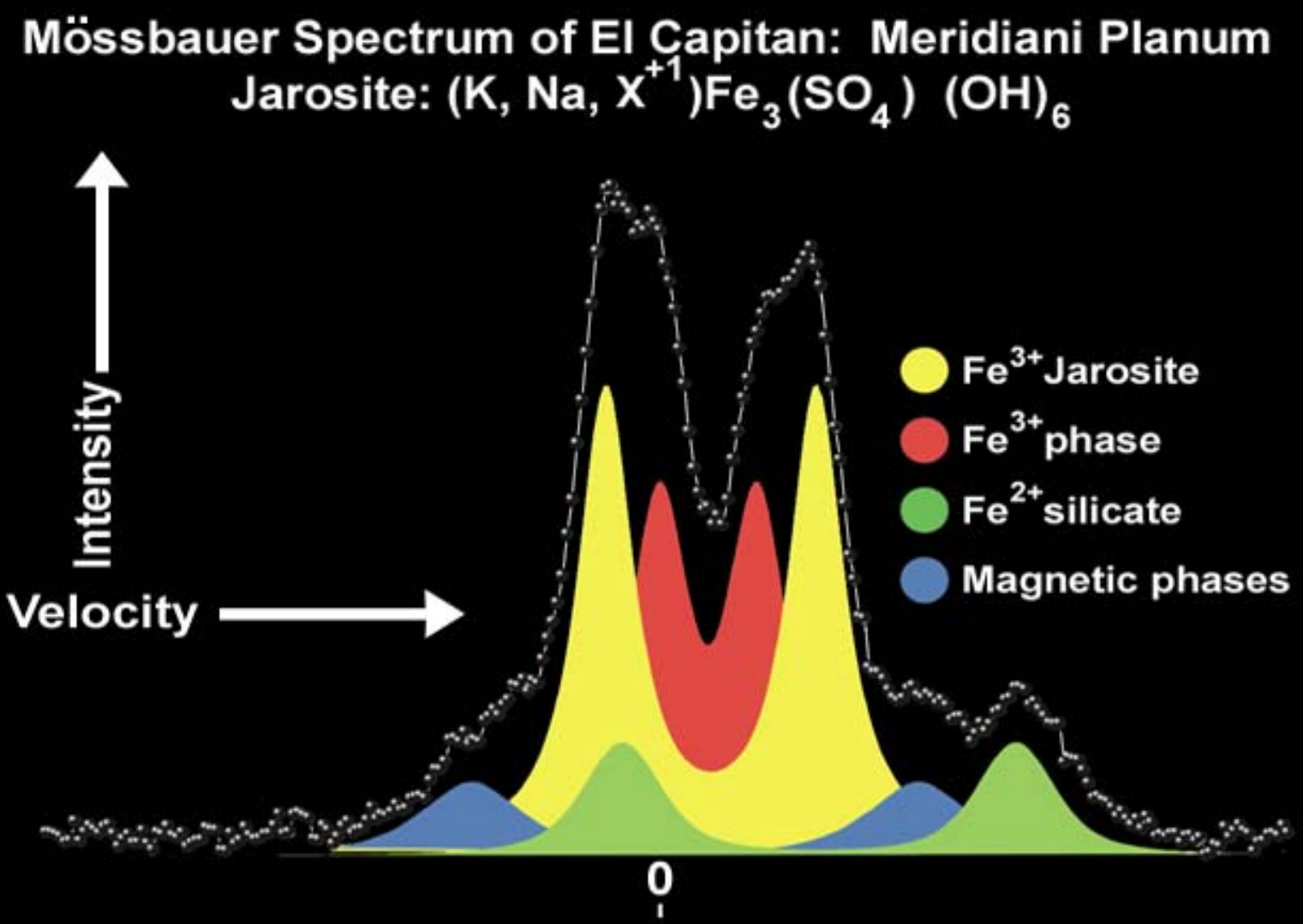


Rock Outcrop In *Eagle* Crater

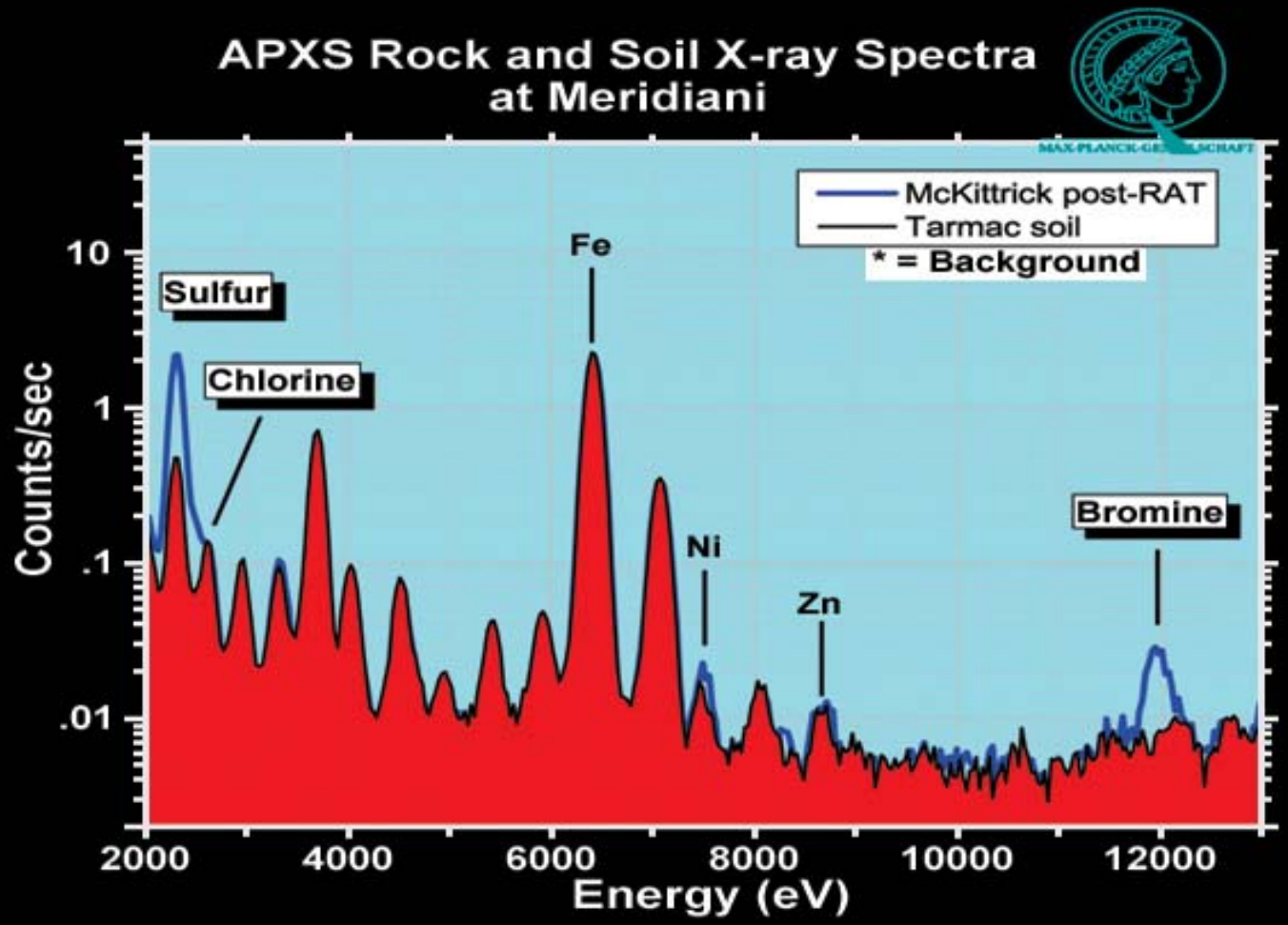


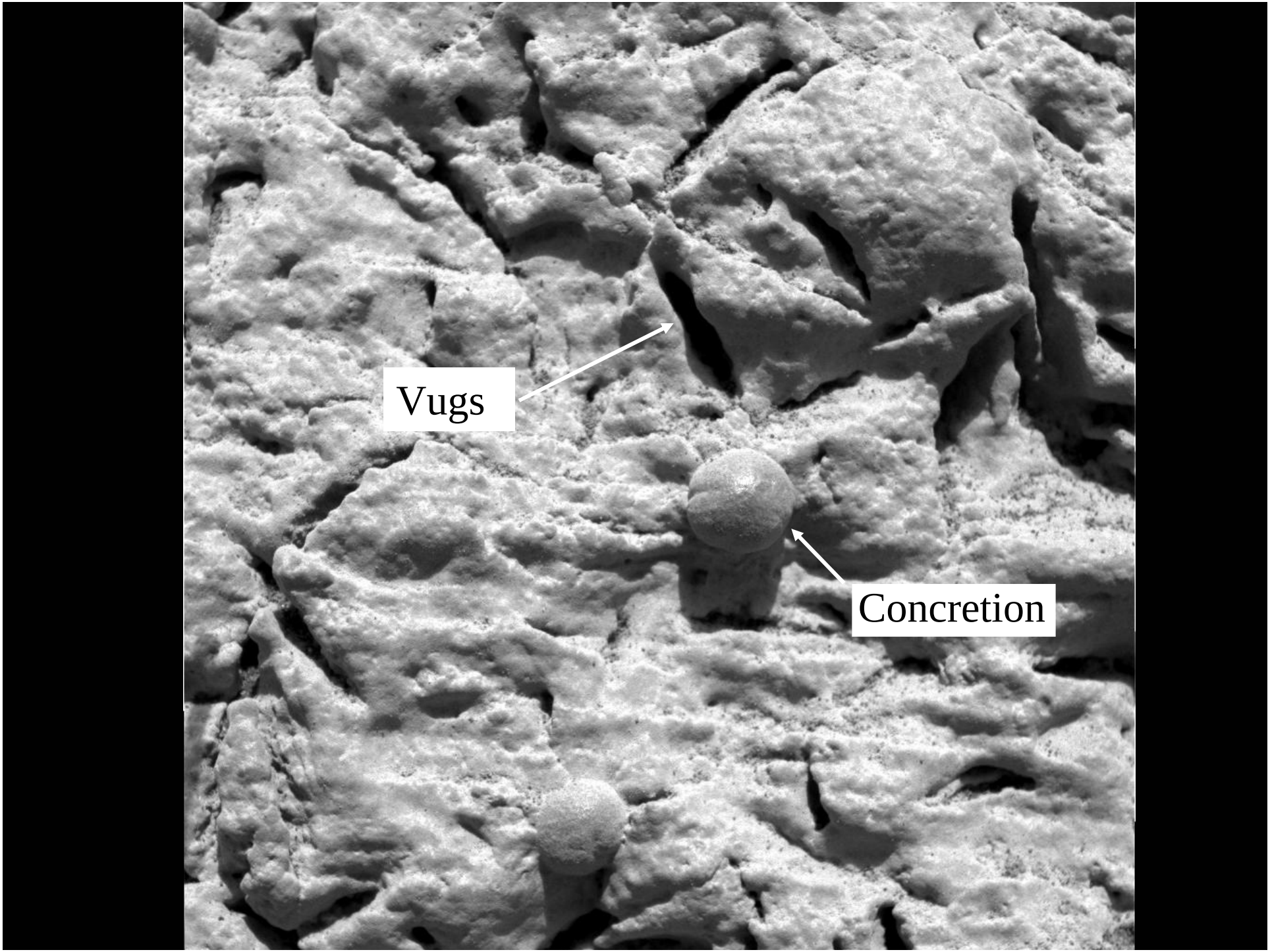


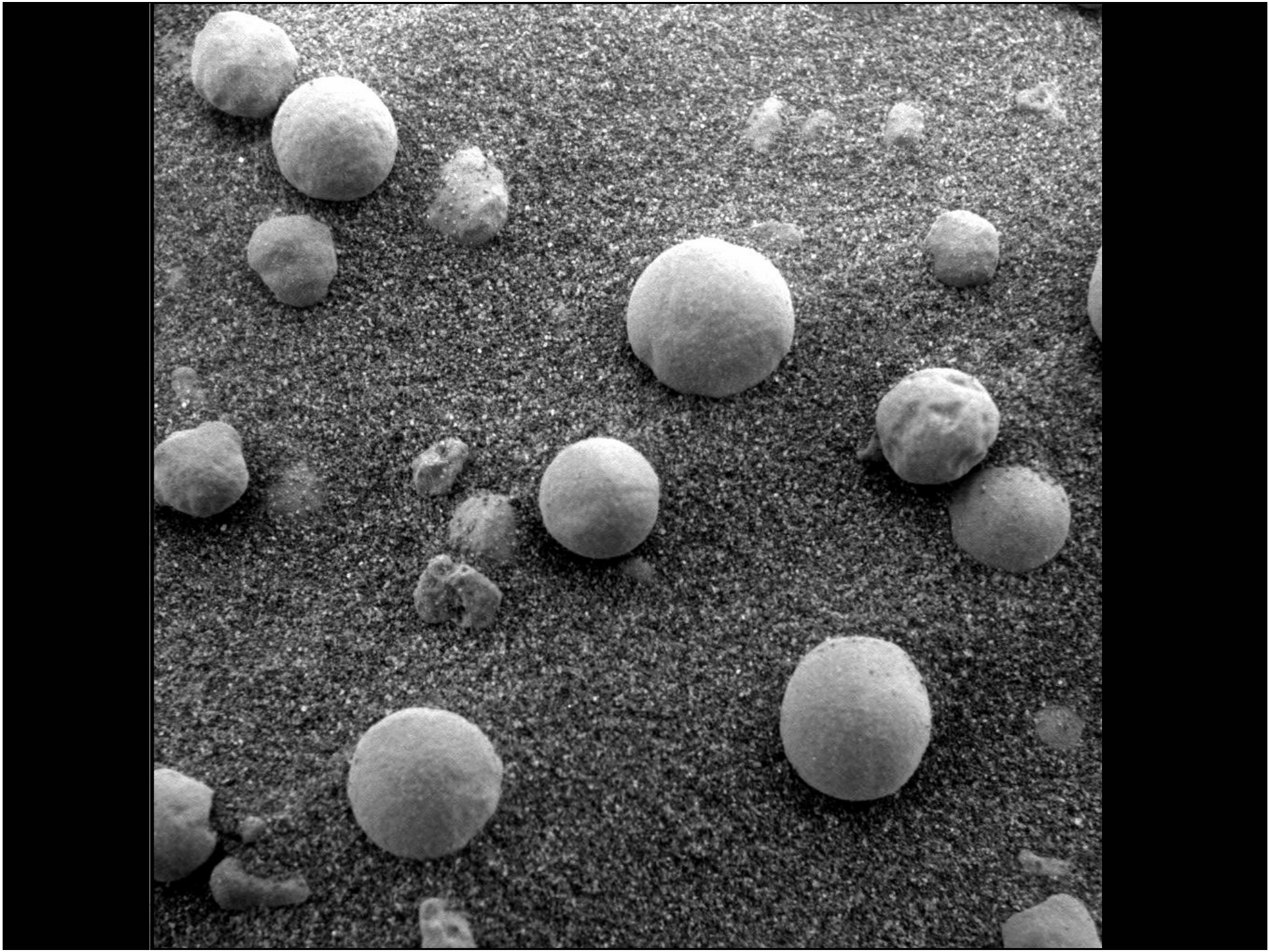
Jarosite Tells of Watery Past

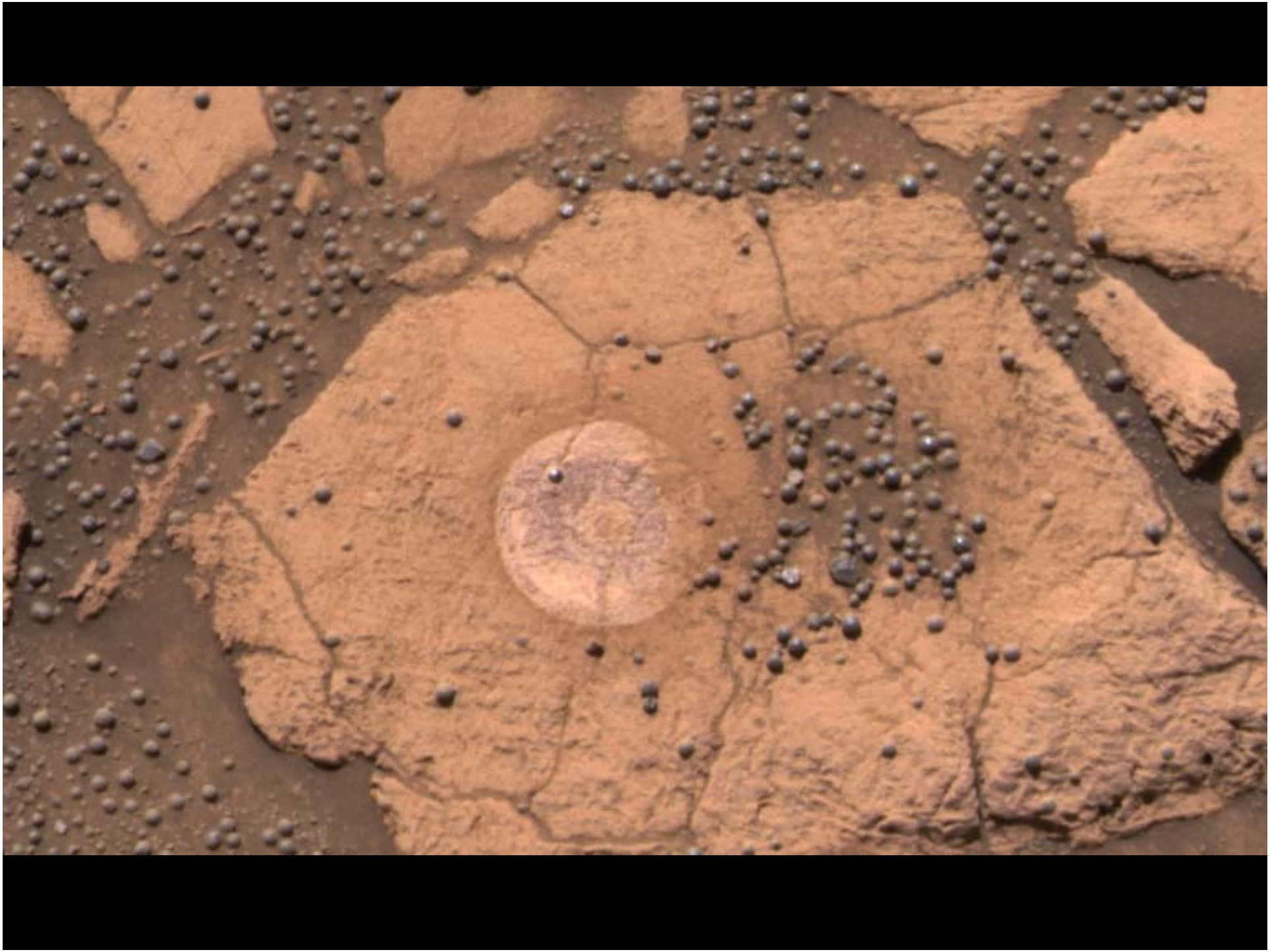


Lots of Sulfur!

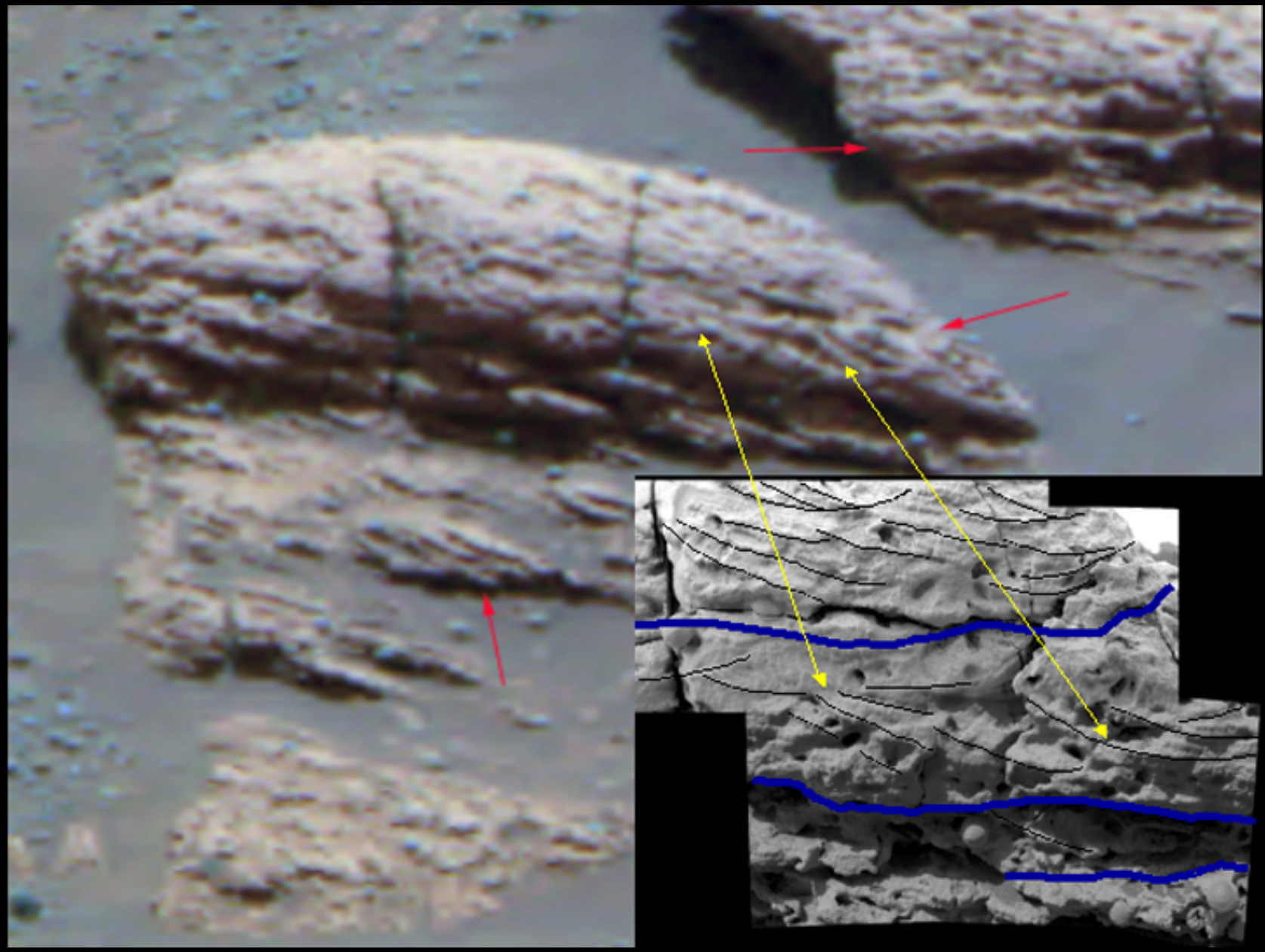



Vugs
Concretion

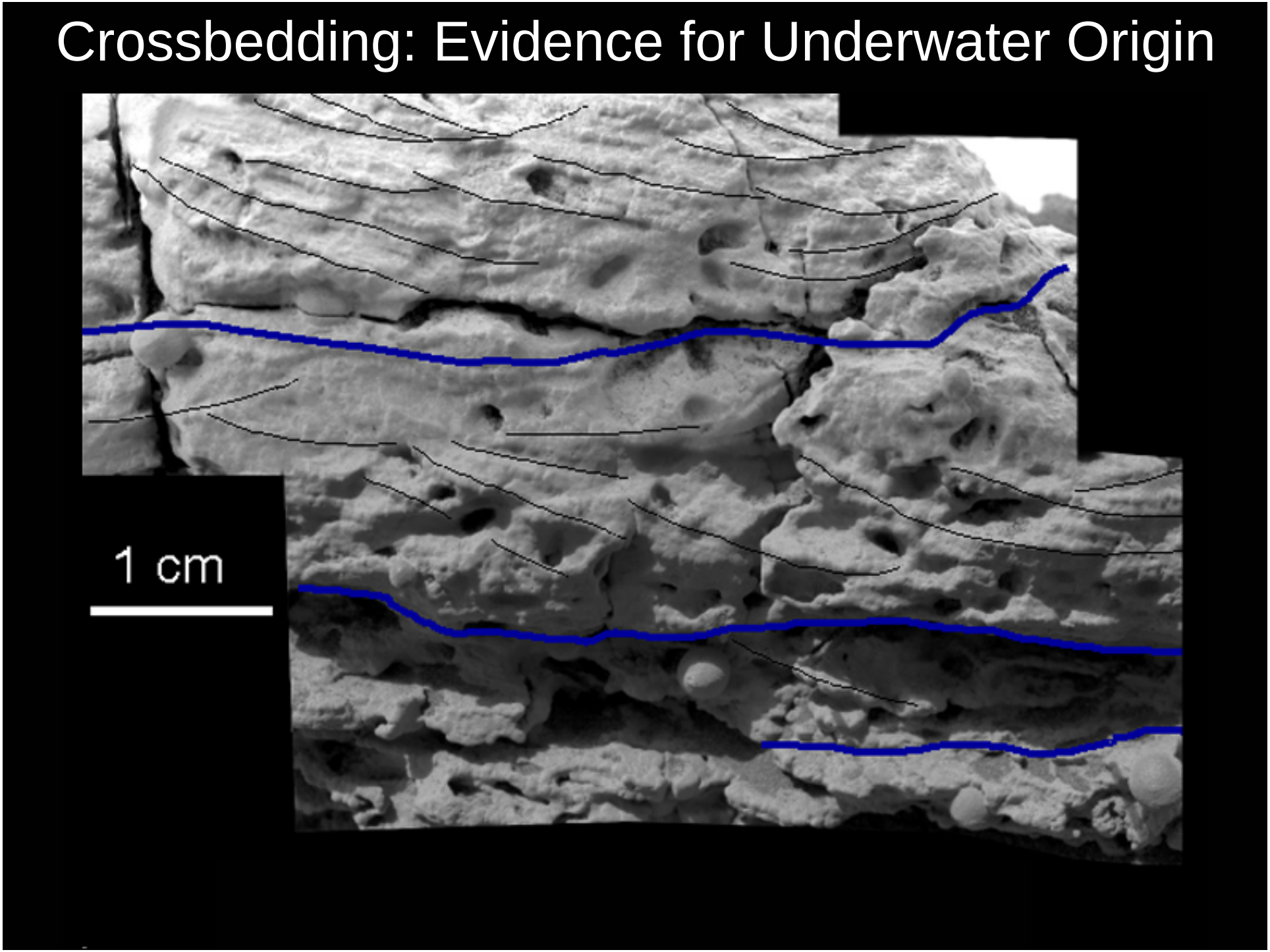




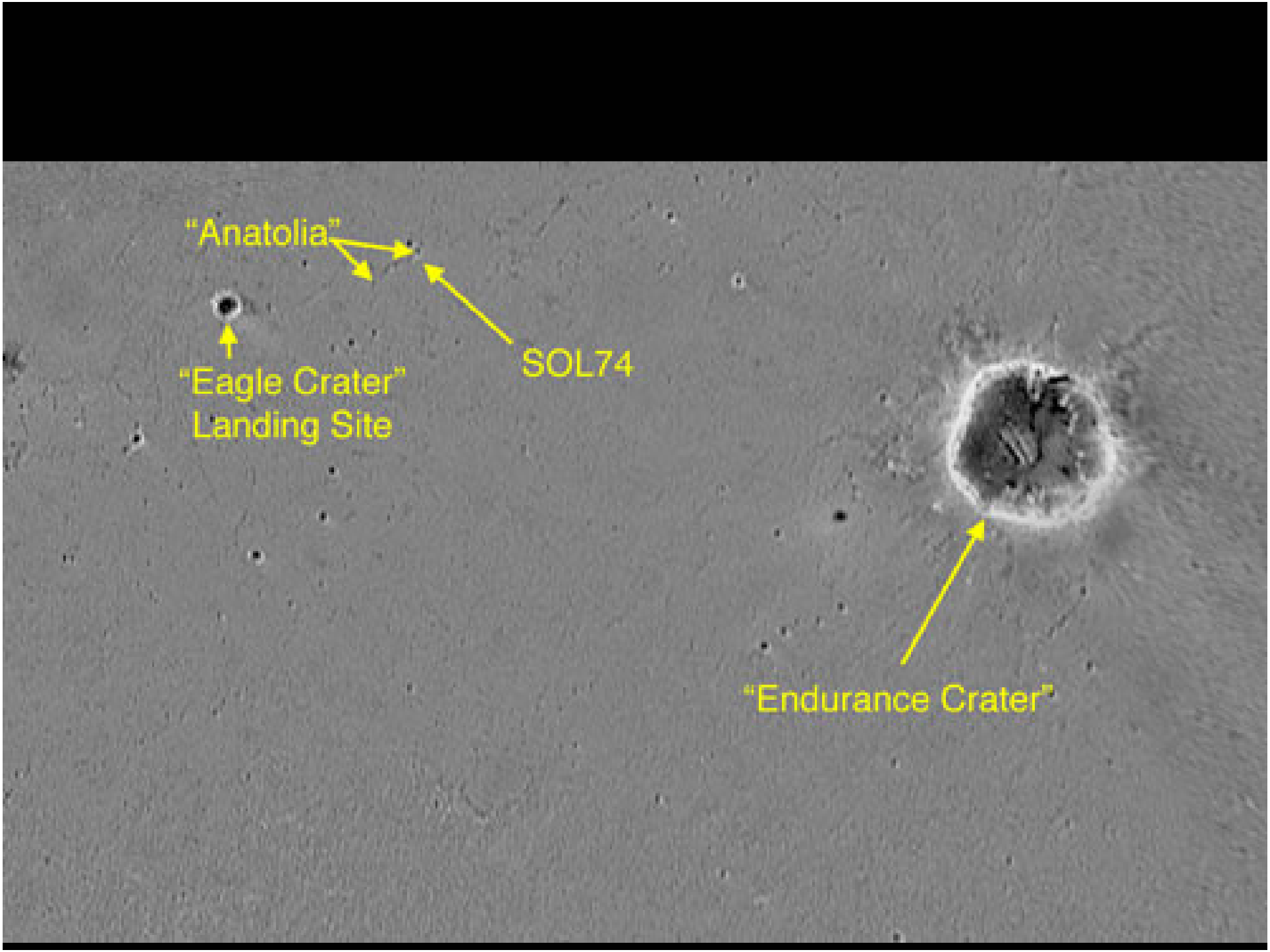
Crossbedding: Evidence for Underwater Origin



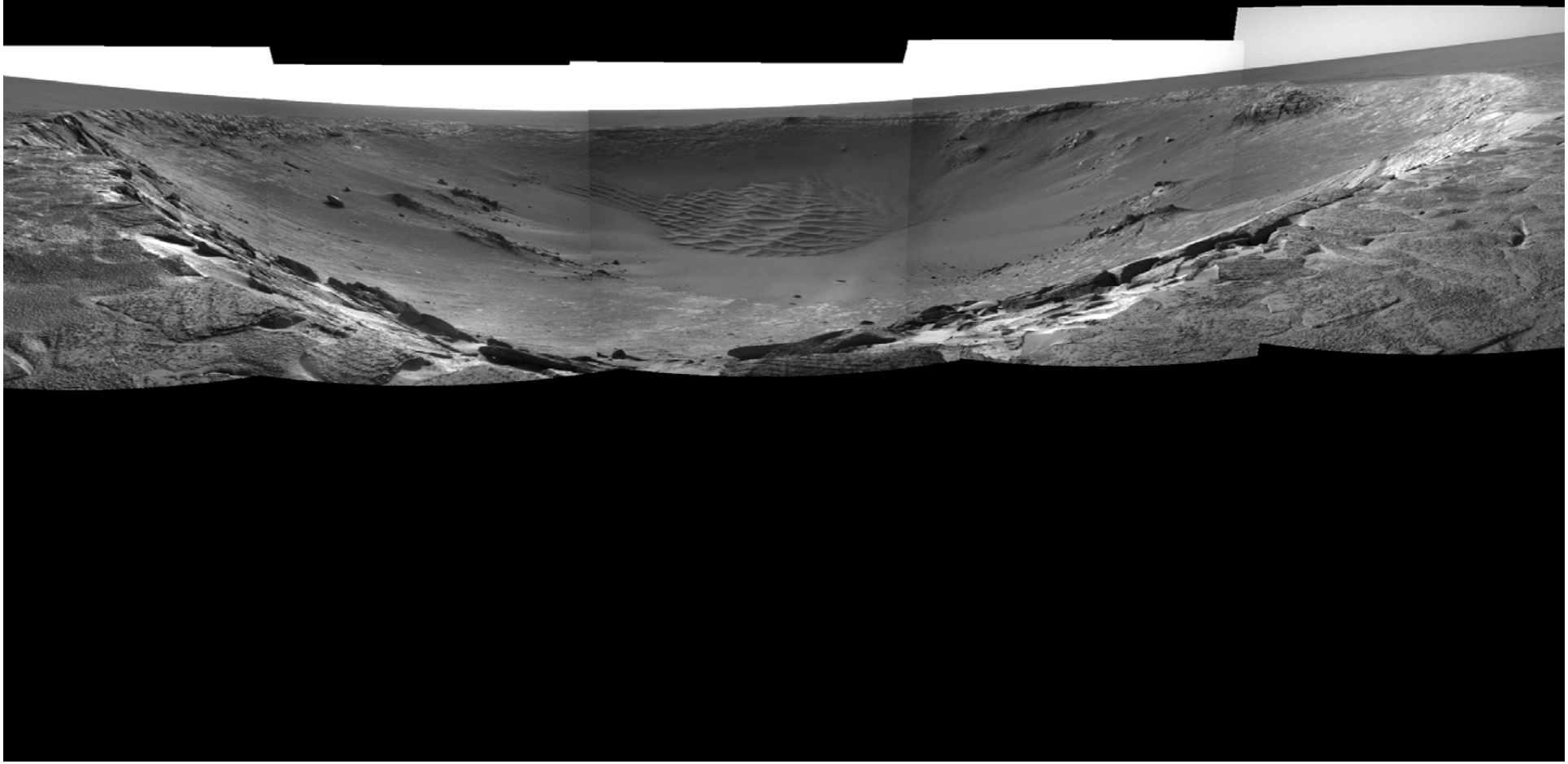
Crossbedding: Evidence for Underwater Origin



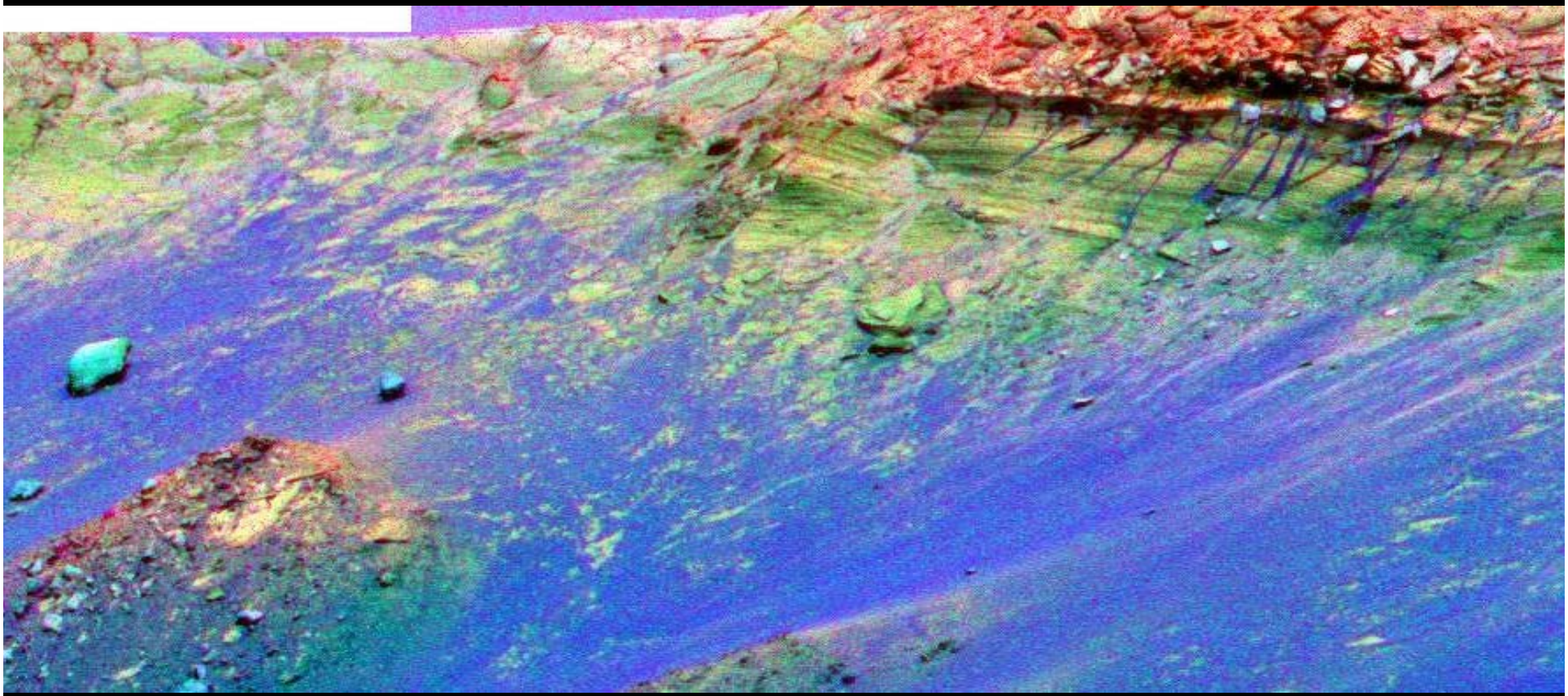

1 cm
Colorado River ripples


"Anatolia"
"Eagle Crater"
Landing Site
SOL74
"Endurance Crater"

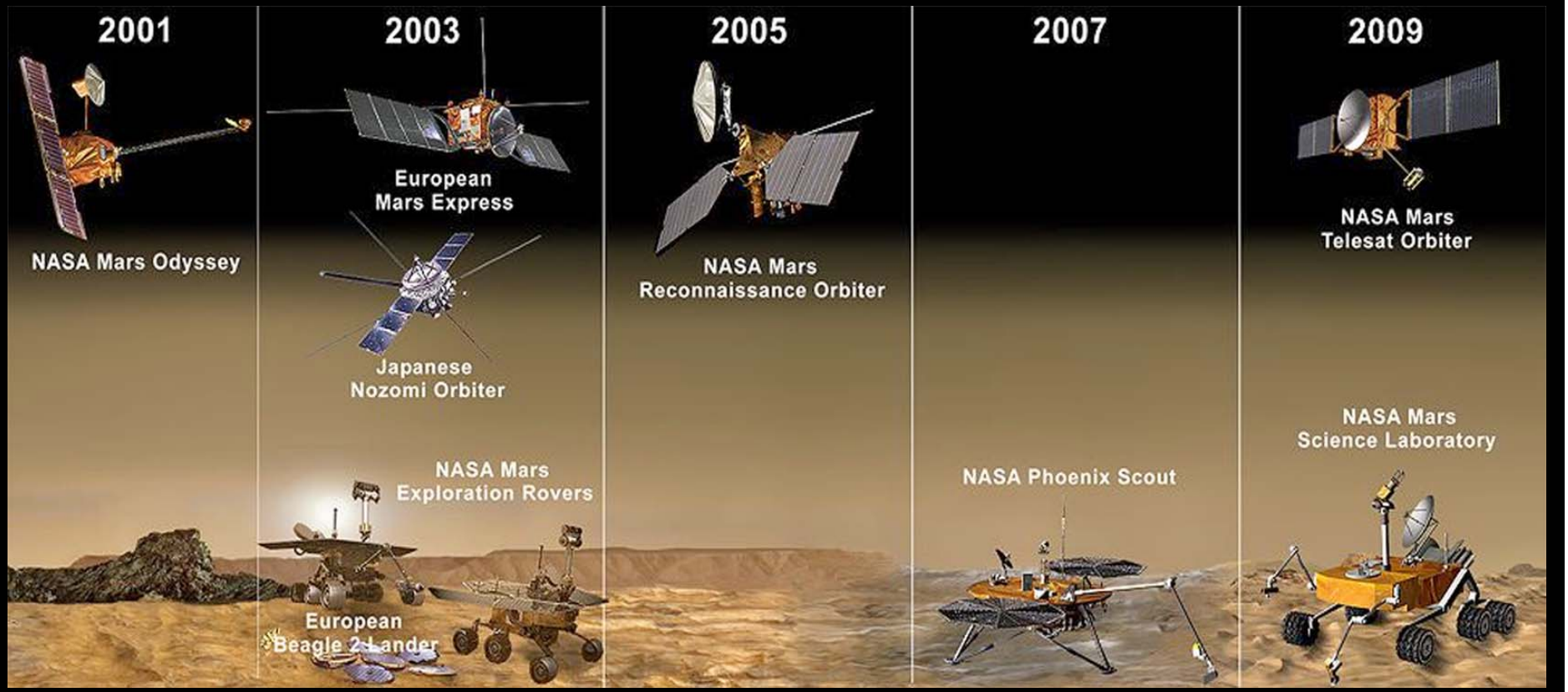
Endurance Crater



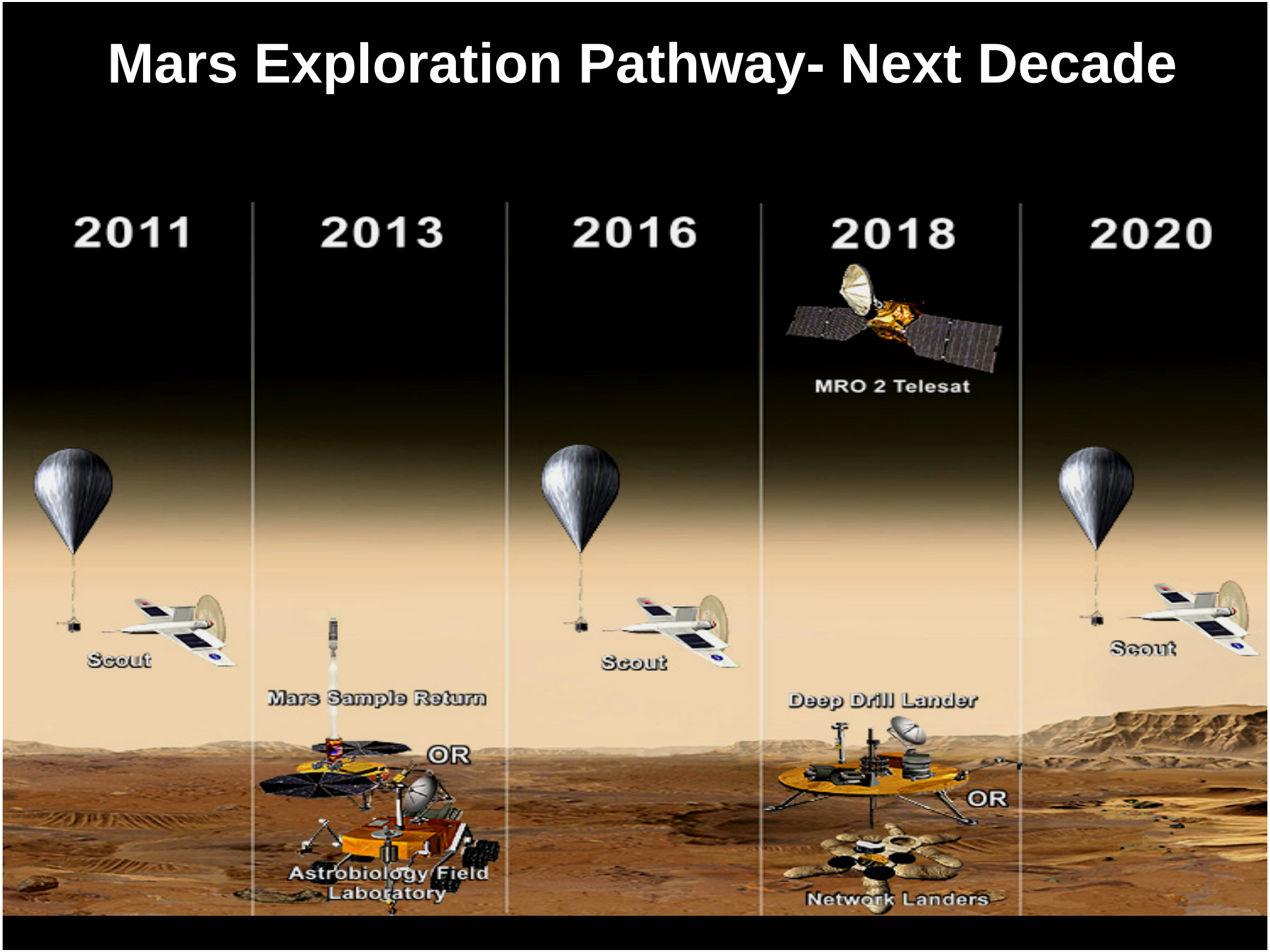
Endurance Crater



Mars Exploration Pathway- This Decade

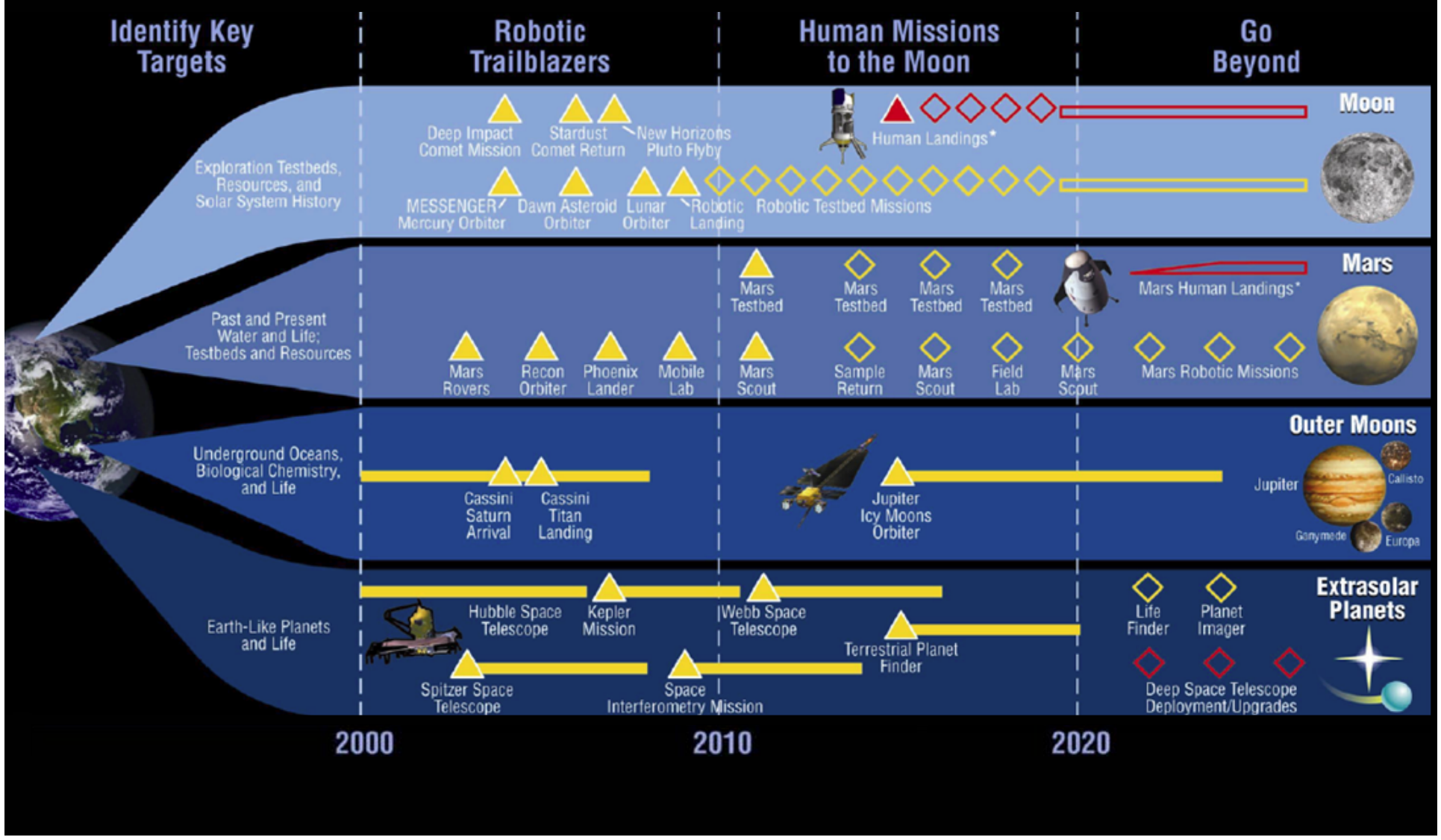


Mars Exploration Pathway- Next Decade

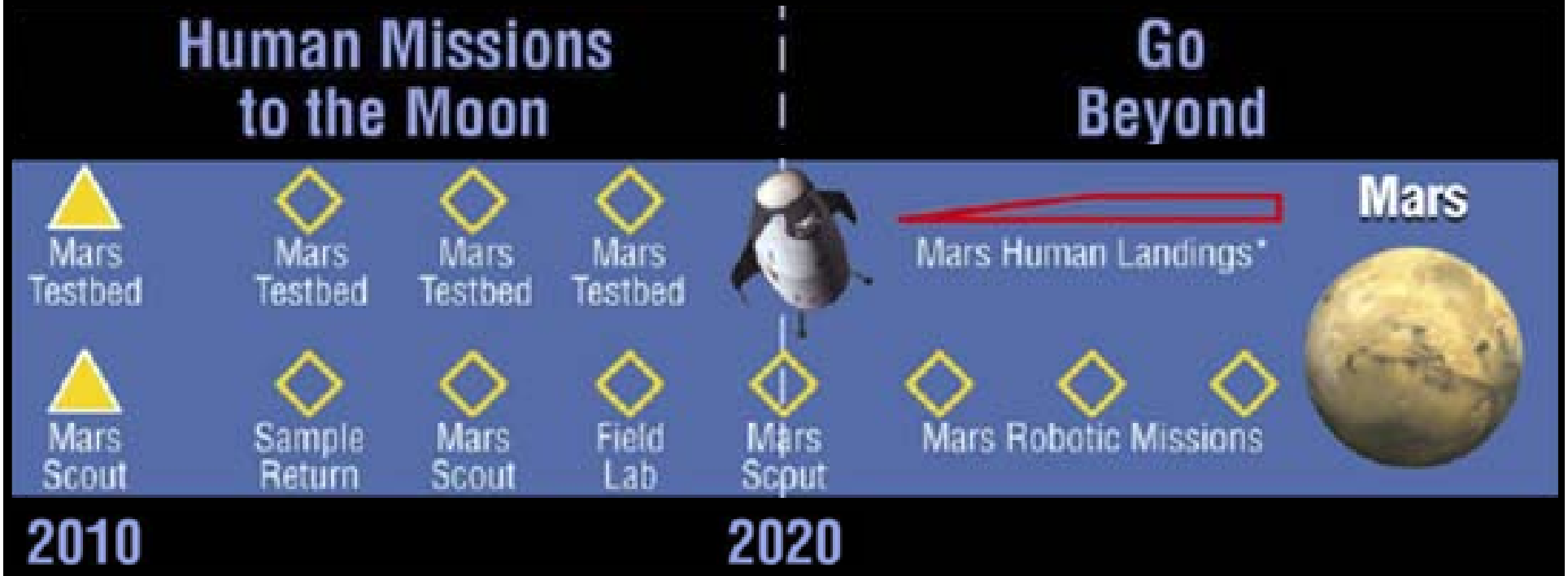


The Vision for Space Exploration:

Missions

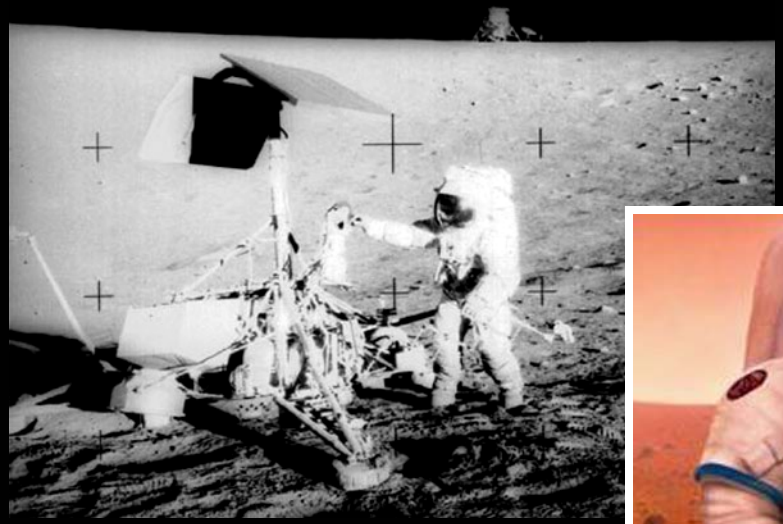


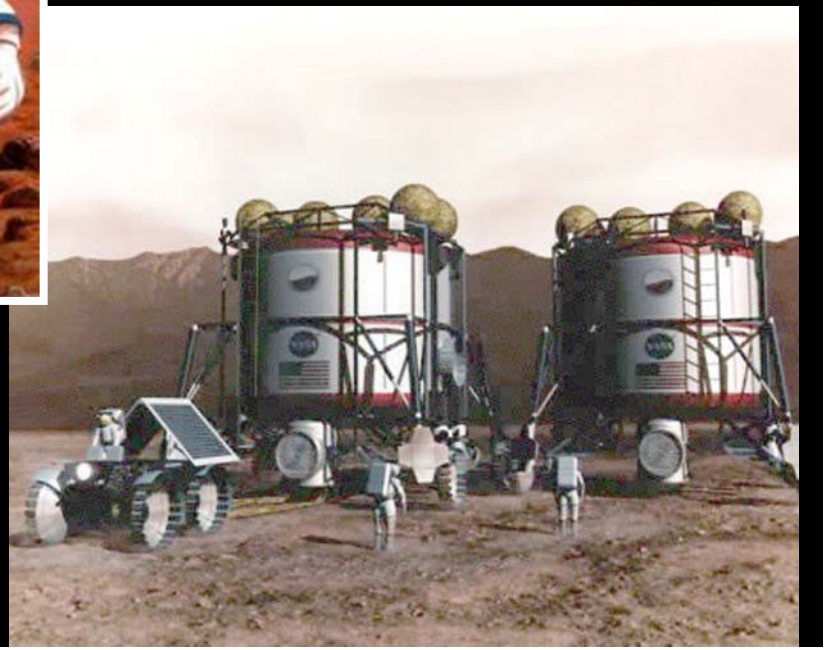
The Vision for Space Exploration: Mars



Mars Sample Return

Future Mars Exploration:
Human Exploration and Science



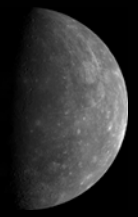


Our Solar System: Forty Years of Exploration

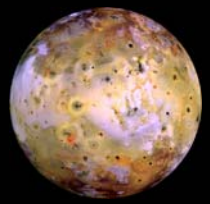
Asteroids

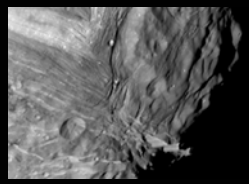
Mars Exploration Program

Terrestrial Planets

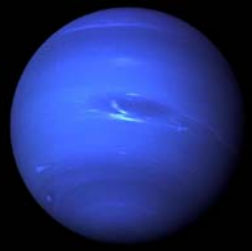


Comets

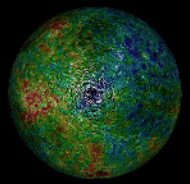


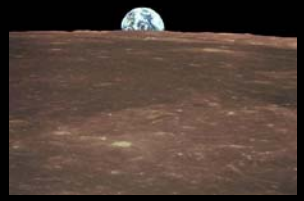


Planetary Satellites



Giant Planets





The Moon

Solar System Exploration Programs

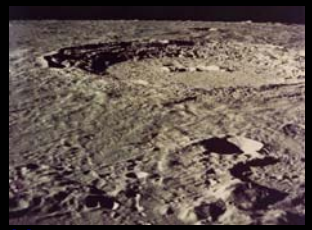
Titan prebiotic chemistry and the Saturnian system

Cassini-Huygens

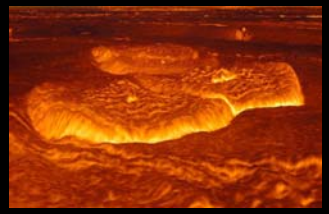
Liquid water and habitable environments

Jupiter Icy Moons Orbiter

Formation and Evolution of Planetary Environments (competed missions)

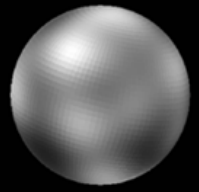


Moon



Venus

Pluto

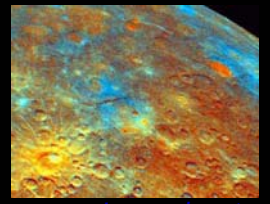


Comets

Jupiter

New Frontiers: Medium missions

Small bodies



Inner planets

Discovery : Small missions

Discovery Missions

Completed

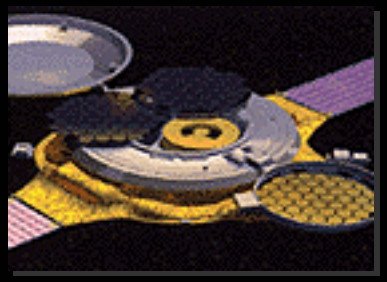
Mars evolution:
Mars Pathfinder

Lunar formation:
Lunar Prospector

NEO characteristics:
NEAR

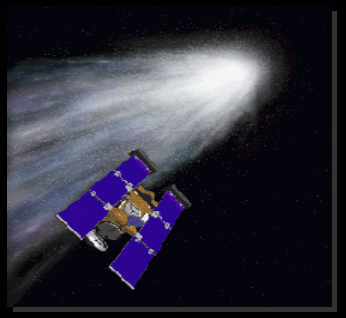
In Flight

Solar wind sampling:
Genesis



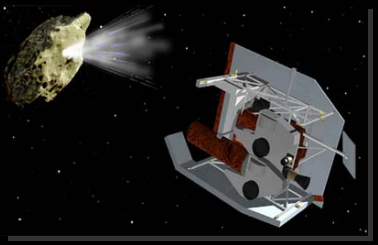
Comet diversity:
CONTOUR

Nature of dust/coma:
Stardust

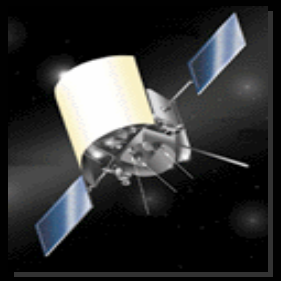


In Development

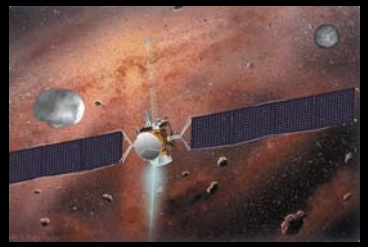
Comet internal structure:
Deep Impact



Mercury environment:
MESSENGER

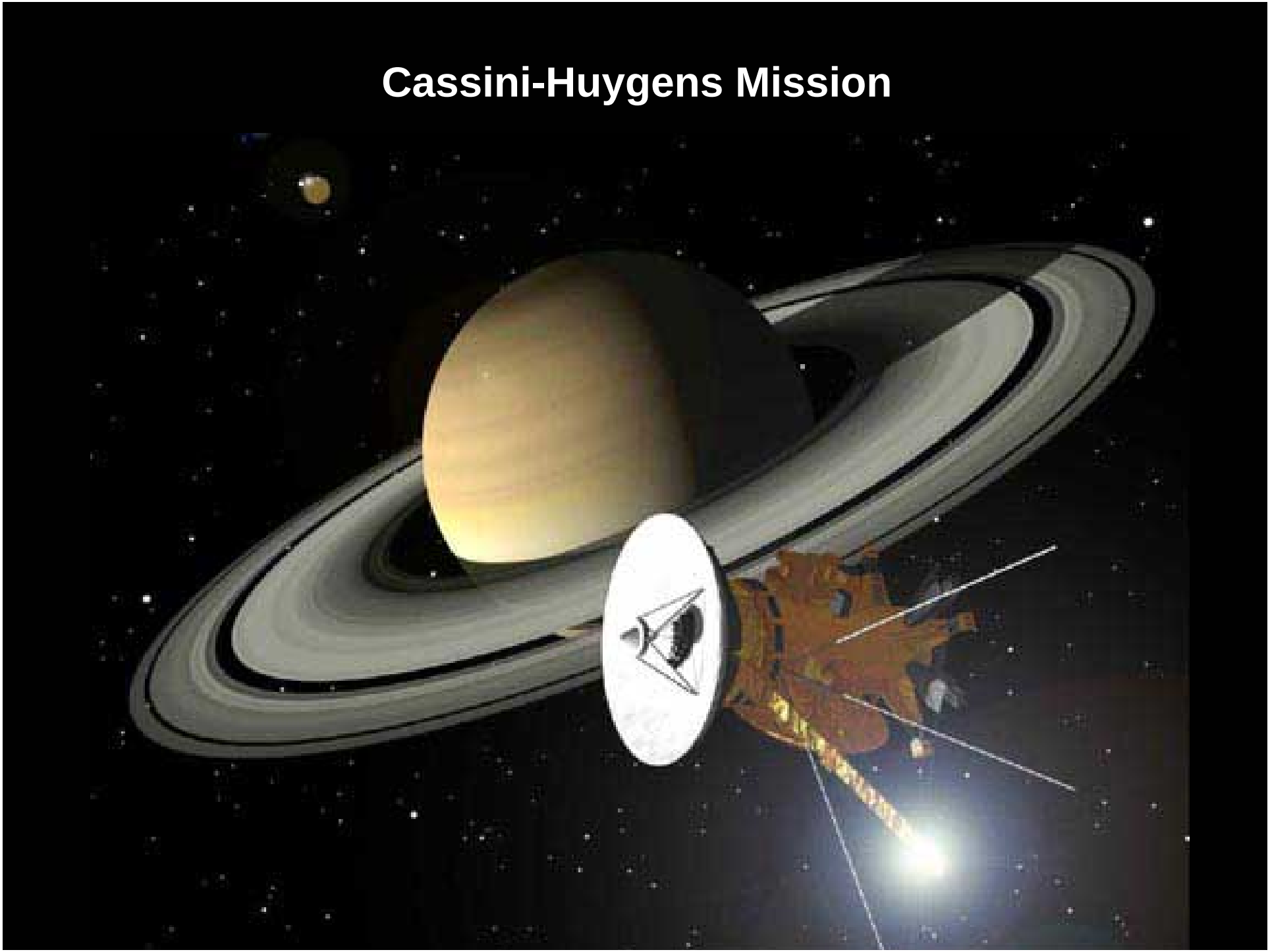


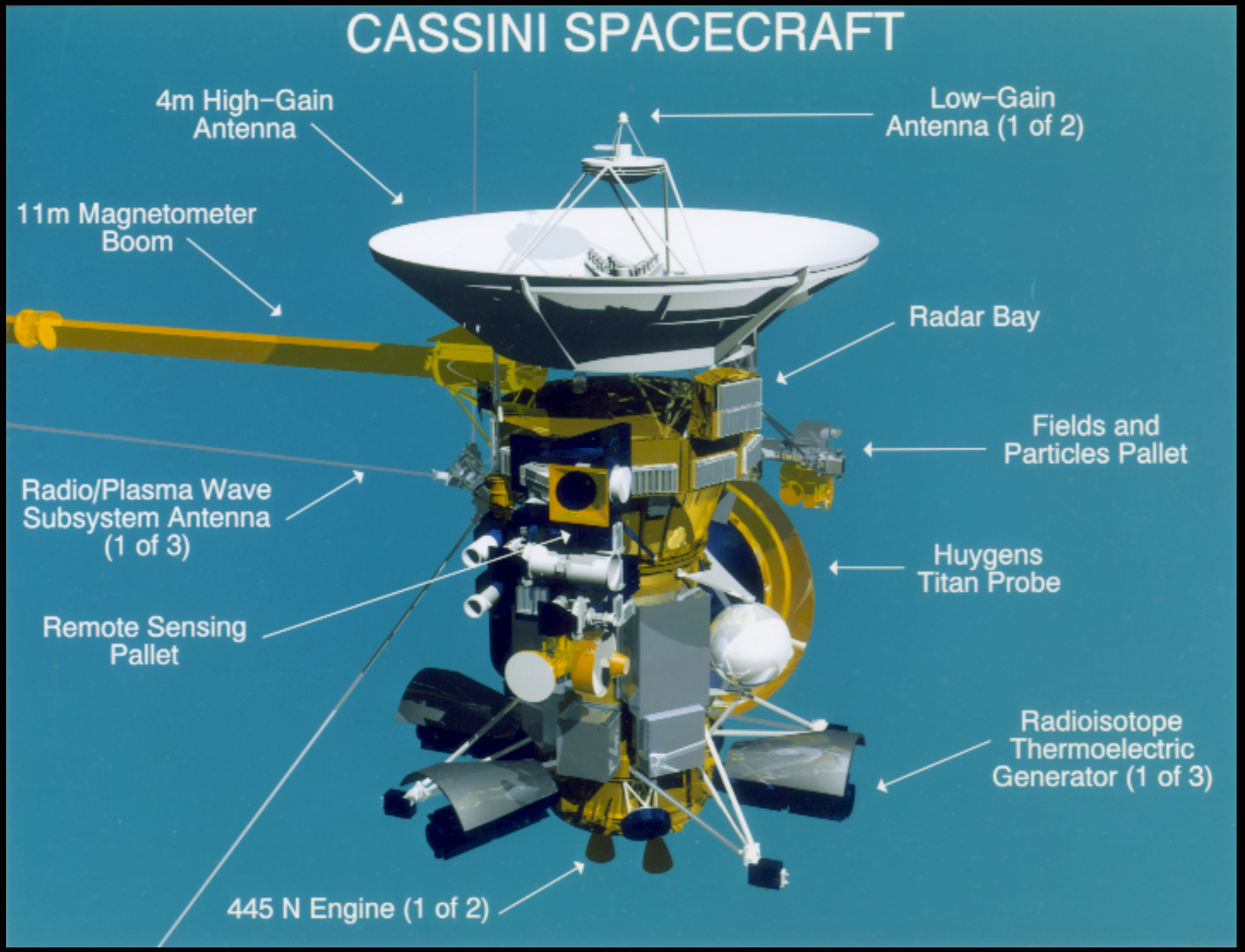
Main-belt
asteroids: Dawn

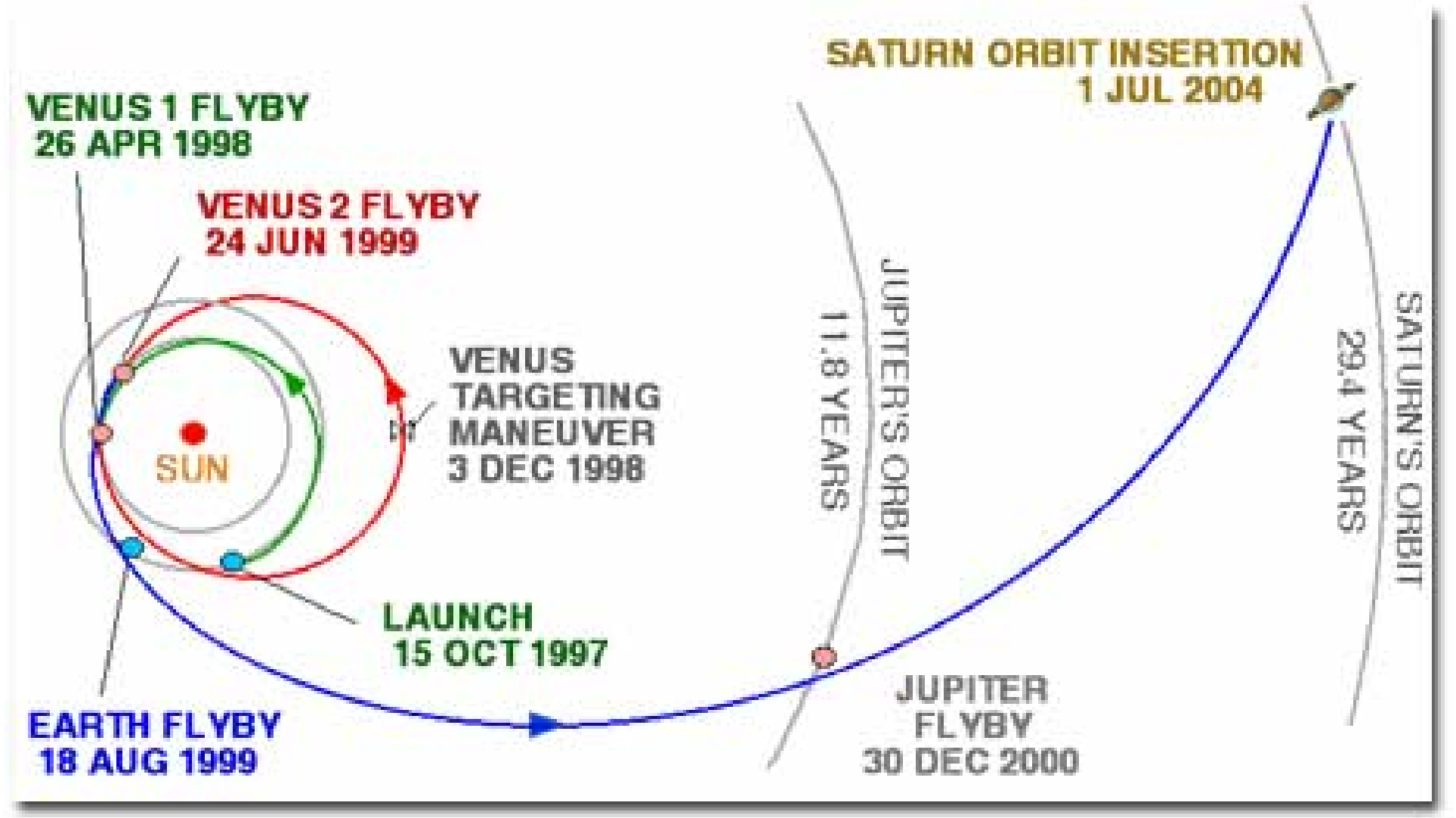


Extra-solar
planets: Kepler

Cassini-Huygens Mission




CASSINI SPACECRAFT
4m High-Gain Antenna
Low-Gain Antenna (1 of 2)
11m Magnetometer Boom
Radar Bay
Fields and Particles Pallet
Radio/Plasma Wave Subsystem Antenna (1 of 3)
Huygens Titan Probe
Remote Sensing Pallet
Radioisotope Thermoelectric Generator (1 of 3)
445 N Engine (1 of 2)


SATURN ORBIT INSERTION
1 JUL 2004
VENUS 1 FLYBY
26 APR 1998
VENUS 2 FLYBY
24 JUN 1999
VENUS
TARGETING
MANEUVER
3 DEC 1998
SUN
JUPITER'S ORBIT
11.8 YEARS
29.4 YEARS
SATURN'S ORBIT
LAUNCH
15 OCT 1997
EARTH FLYBY
18 AUG 1999
JUPITER
FLYBY
30 DEC 2000

Cassini-Huygens Approaches Orbital Insertion

Image acquired on
May 21, 2004

Stay tuned for much much more!!

Office of Competed Missions and Science Instruments

- **For the Office of Competed Missions and Science Instruments program, there is one potential industry procurement, and that is for planetary spacecraft**

- **Opportunities over the next 3-5 years include:**
  - **Discovery 2004**
    - **Teaming arrangements already in place for this opportunity**
  - **Discovery 2006**
    - **Time frame: calendar 2005**
  - **Mars Scout 2011**
    - **Time frame: calendar 2005-6**
  - **Discovery 2008**
    - **Time frame: calendar 2008**

Gregg Vane
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NOTE: **Actual timeframe for future Discovery and Mars Scout opportunities are subject to the vagaries of NASA funding, of course**

Mars Telecommunication Orbiter Project

Project Focus: Develop a flight and ground system for launch in 2009. Key attributes of this project include:

- **Robust relay communication capabilities**
- **Demonstration of new technology including laser communication between Mars and Earth; autonomous navigation, rendezvous with orbital assets**
- **Orbital science experiment**

NASA Technology Teaming Opportunities:

- **Industry procurement of the flight system**
  - **Large orbiter class spacecraft**
- **Industry procurement of X and Ka band microwave communication equipment**
- **Components of rendezvous and auto-navigation demonstrations (gimbals, orbital sample canister, uhf beacon)**

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Roger.G.Gibbs@jpl.nasa.gov

Life Detection Science & Technology Program

Office Focus: Development of life detection science strategies, in situ sensors and instruments through advanced micro-, bio-, and nano-technology

NASA Technology Teaming Opportunities:

- **Office of Space Science Research Announcements for astrobiology technology development and planetary protection**
- **Office of Exploration Systems Announcements for advanced sensors, electronics, and nanotechnology**
- **Office of Biological and Physical Research Research Announcements on environmental monitoring and controls systems for crewed vehicles**

Tim Krabach
Manager, Life Detection Science and Technology Program
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E-mail address:
Timothy.N.Krabach@jpl.nasa.gov

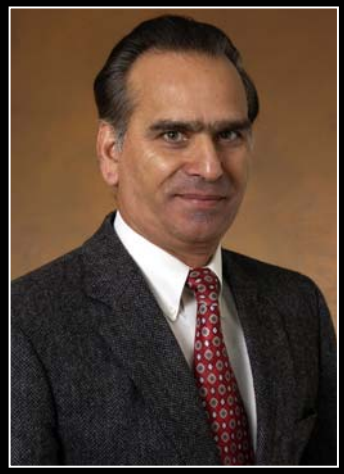
Non-NASA Teaming Opportunities:

- Targeted funding opportunities with DARPA, FAA, NIH, and other government agencies that are synergistic with the office focus on physical, chemical, and biological sensing methods

Space Exploration Technology Program

Office Focus: Develop technologies to meet the needs of the Solar System Exploration Programs and the Exploration Systems Office, in the following areas:

- **Power**
- **Propulsion**
- **Entry/Descent Landing**
- **Avionics**
- **Mobility/Robotics/Sample Acquisition**



Satish Khanna
Manager
Space Exploration Technology Program
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Satish.K.Khanna@jpl.nasa.gov

NASA Technology Teaming Opportunities:
Opportunities exist to team up with JPL to respond to the following NASA Office of Space Science (Code S) and Office of Exploration Systems (Code T) solicitations:

1. New Millennium Program
2. In-Space Propulsion Technology Program
3. Prometheus Technology Program
4. Human & Robotics Technology Program (Code T)

Non-NASA Technology Teaming Opportunities:
Opportunities exist to team up with JPL and jointly respond to non-NASA prospects in the above mentioned technology areas.

Mars Science Laboratory Project

Project Objectives: Develop a mission to Mars to launch in the 2009 which:

- **is a mobile science laboratory**
- **has a mission lifetime of hundreds of days on the surface**
- **can be targeted over a range of latitudes and altitudes, and**
- **utilizes propulsion and guided entry to land at selected sites.**

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Manager, Mars Science Laboratory Project
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Peter.C.Theisinger@jpl.nasa.gov

NASA Teaming Opportunities:
Opportunities exist to respond to the following project solicitations:

- **Cruise stage, lander and rover subsystems (FY'06)**
- **Mechanical hardware fabrication (FY'07)**
- **Ground software development (FY'06 – FY'07)**
- **Support contractors (FY'06 – FY'08)**

New Millennium Program

A program to identify and flight validate breakthrough technologies that will significantly benefit future Space Science missions.

Christopher Stevens
Manager, New Millennium Program
Phone: (818) 354-5545
E-mail: Christopher.M.Stevens@jpl.nasa.gov

- Technology -Focused Projects
- Breakthrough Technologies Requiring Flight Validation
- Multi-Mission Technology Benefits
- Partnership/Shared Launches

Integrated System and Subsystem Experiment Validation Projects

Opportunity	Solicitation	Launch
Space Technology 8 (subsystem)	08/02 – Technology Providers	late 2007
Space Technology 8 (spacecraft)	03/05 – Spacecraft Procurement	late 2007
Space Technology 9 (system)	07/03 – System Concepts	early 2009
	6/04 – Technology Providers	early 2009
Space Technology 10 (subsystem)	10/06 – Technology Providers	late 2010
Space Technology 10 (spacecraft)	3/07 – Spacecraft Procurement	late 2010
Space Technology 11 (system)	10/07 – System Concepts	early 2012
	3/08 – Technology Providers	early 2012

Solar System Exploration Programs Technology Programs

Office Focus:

- Define the technology vision and formulate strategic plan for solar system exploration programs at JPL

- Integrate directorate's technology programs to achieve alignment with the vision and strategic needs

- Foster partnerships with other NASA Centers and technology providers for meeting solar system exploration technology needs.

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Solar System Exploration Technologies

Spacecraft Technologies	In Situ Exploration and Sample Return	Science Instruments
Deep Space Power	Entry Descent and Landing	Passive Remote Sensing
In Space Propulsion	Surface & Atmospheric Mobility	Active Remote Sensing
Avionics	Severe Environments Technologies	In Situ Sensing
Guidance, Navigation & Control	Sample Acquisition & Handling	Advanced Devices
Telecommunications	Planetary Protection	

Requirements Only