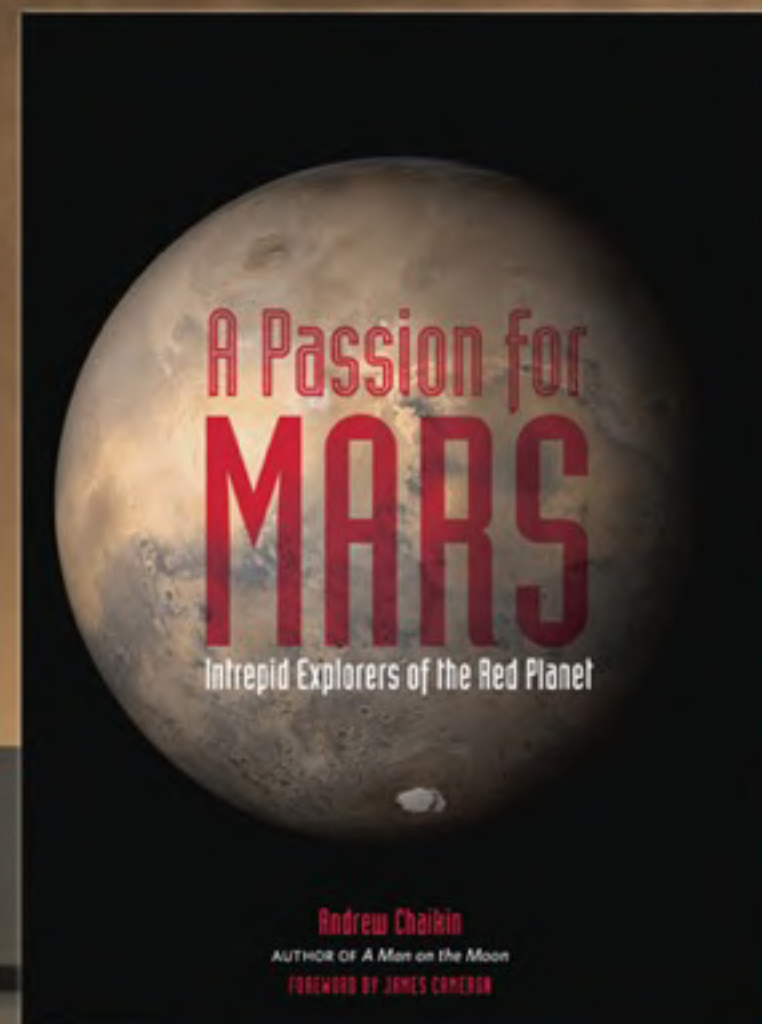


# The Quest for Mars

Andrew Chaikin

12-21-10

# A PASSION FOR MARS





# Siren Song

An illustration of two astronauts in white suits standing on a rocky, yellowish peak. One astronaut is pointing towards a bright star in a dark blue, starry night sky. A small red planet is visible in the upper right corner of the sky. The scene is set against a deep blue background filled with numerous white stars of varying sizes.

Now look out at the sky.  
Do you see that big dot up there?  
That is Mars.  
Mars is a long, long way  
from the moon.  
What would you find on Mars?

No one knows yet.  
But some day you may go there, too!  
Then YOU will see.

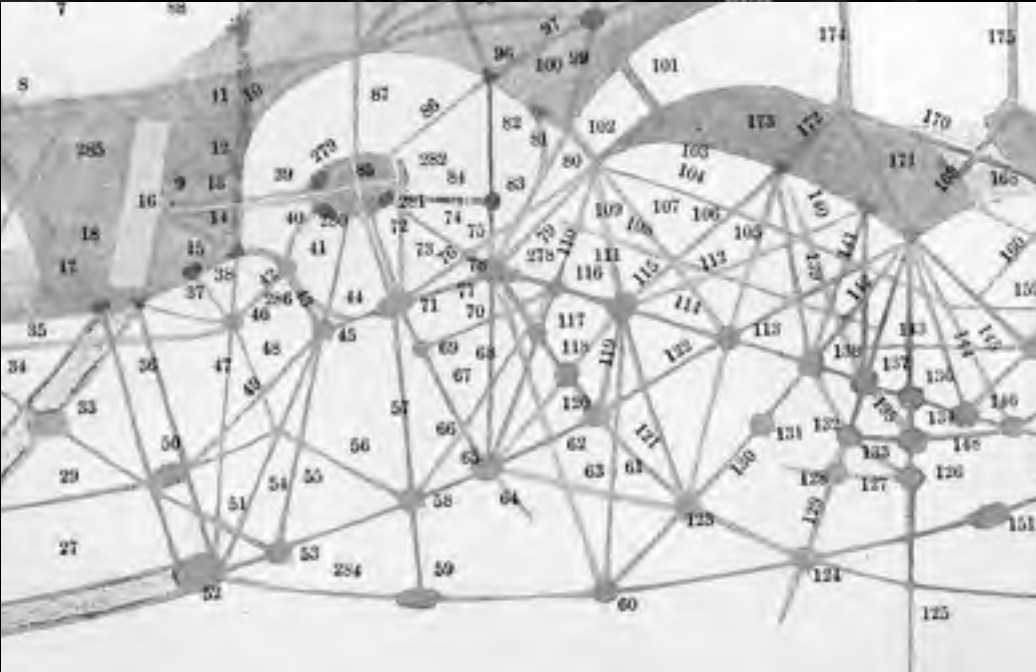


# Mars: A magnet for human curiosity

Percival Lowell (1909)



1919



1895: Lowell's canals



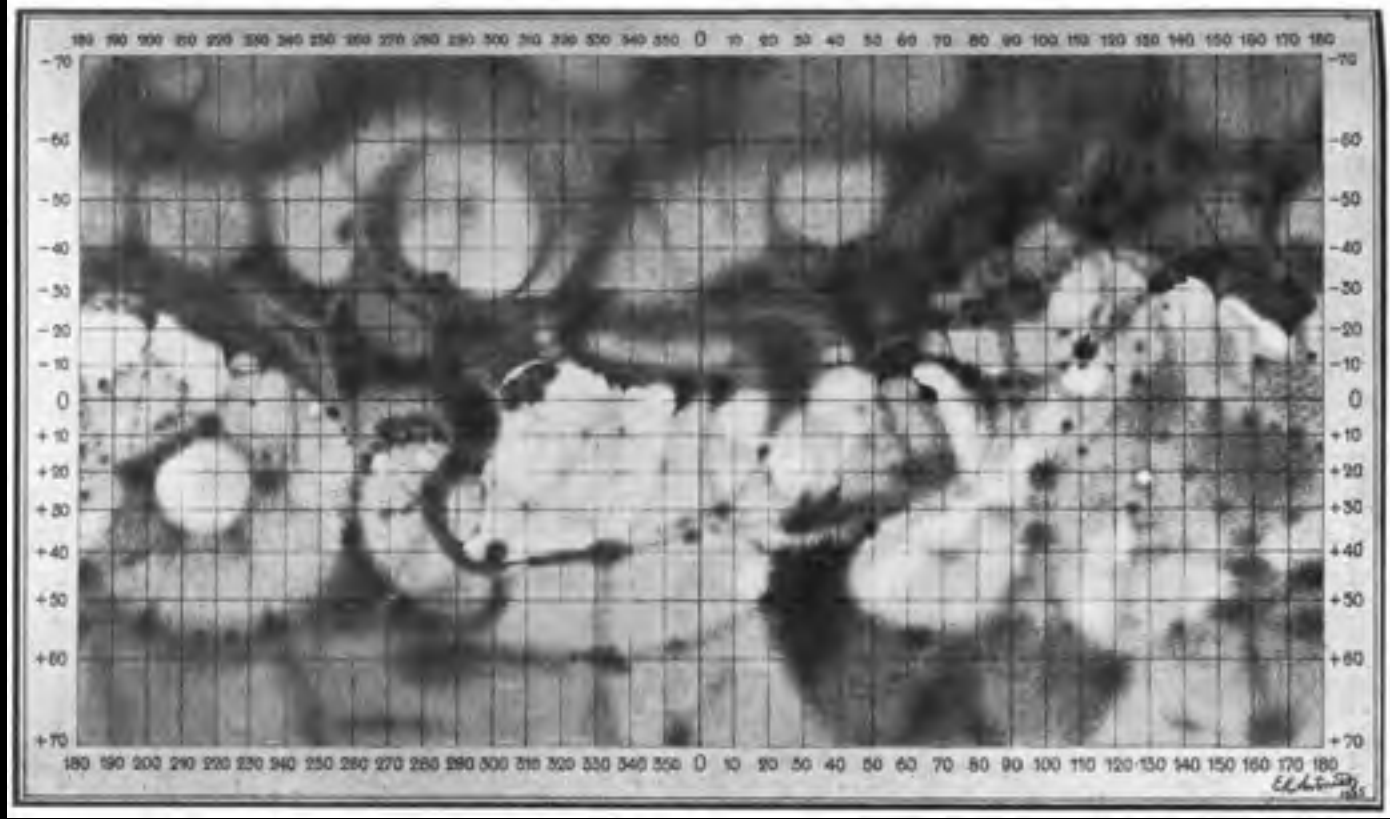
1938



1953



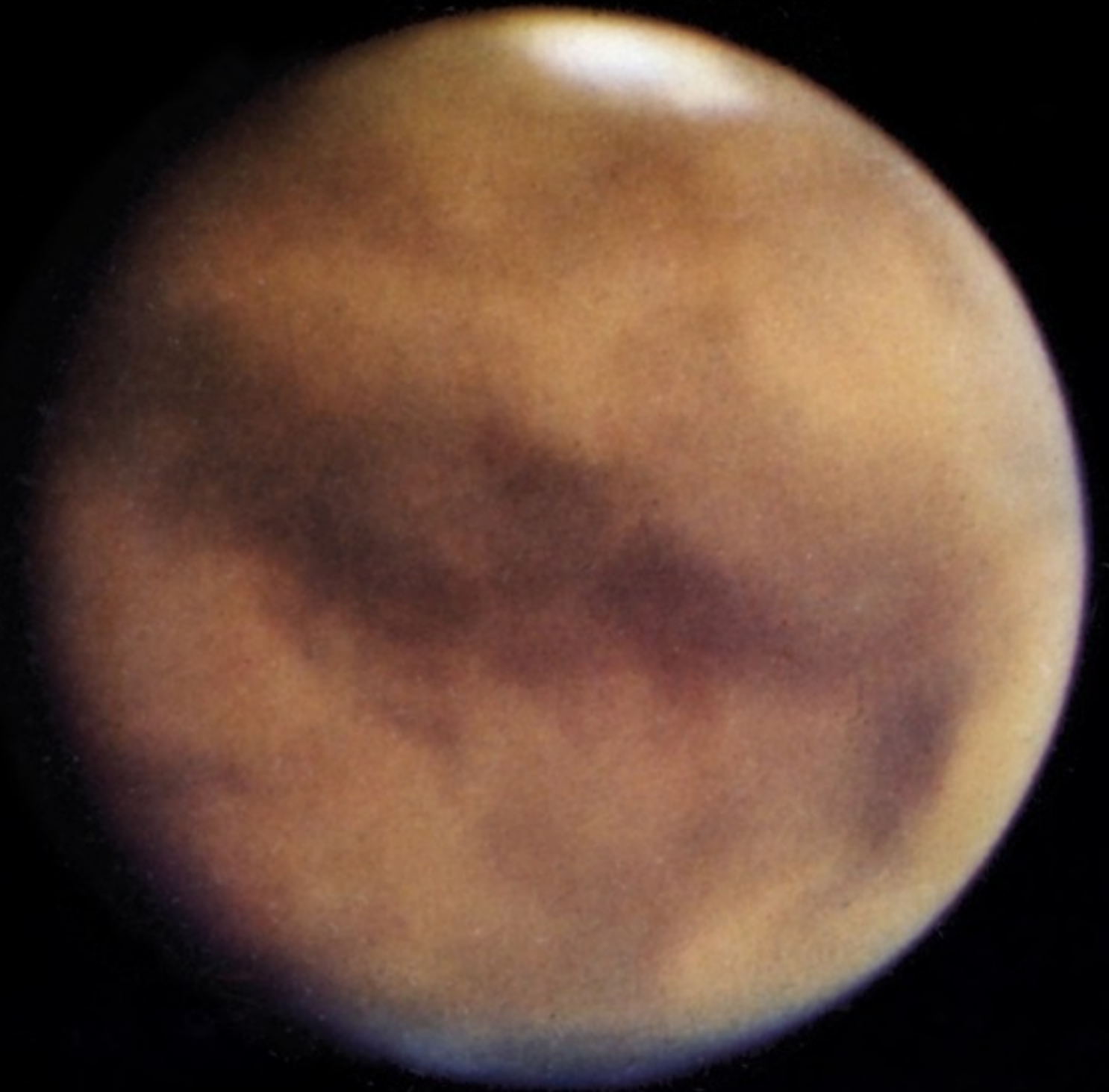
# Mars before the space age



*1930: Mars map by French observer E.M. Antoniadi*



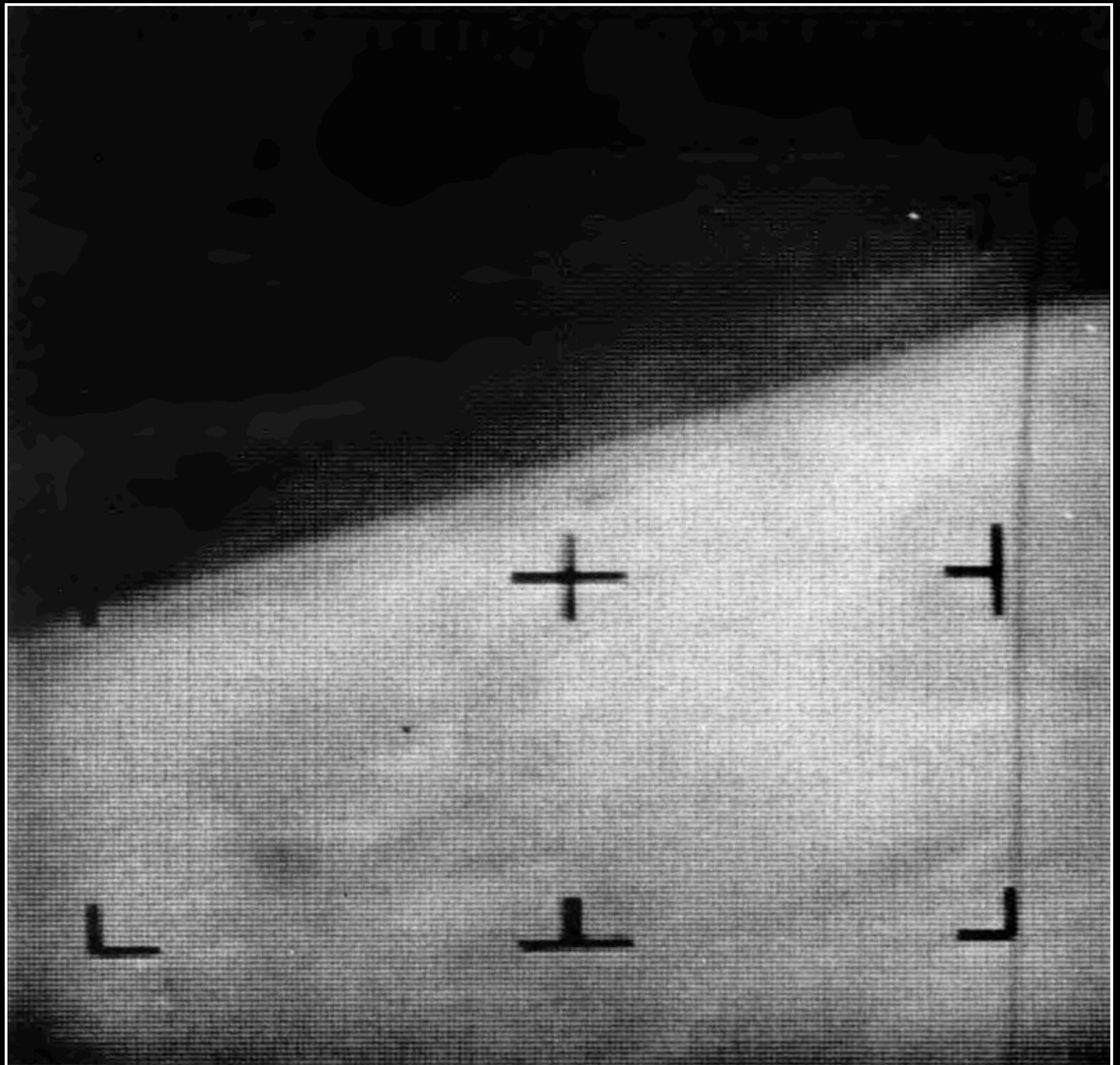
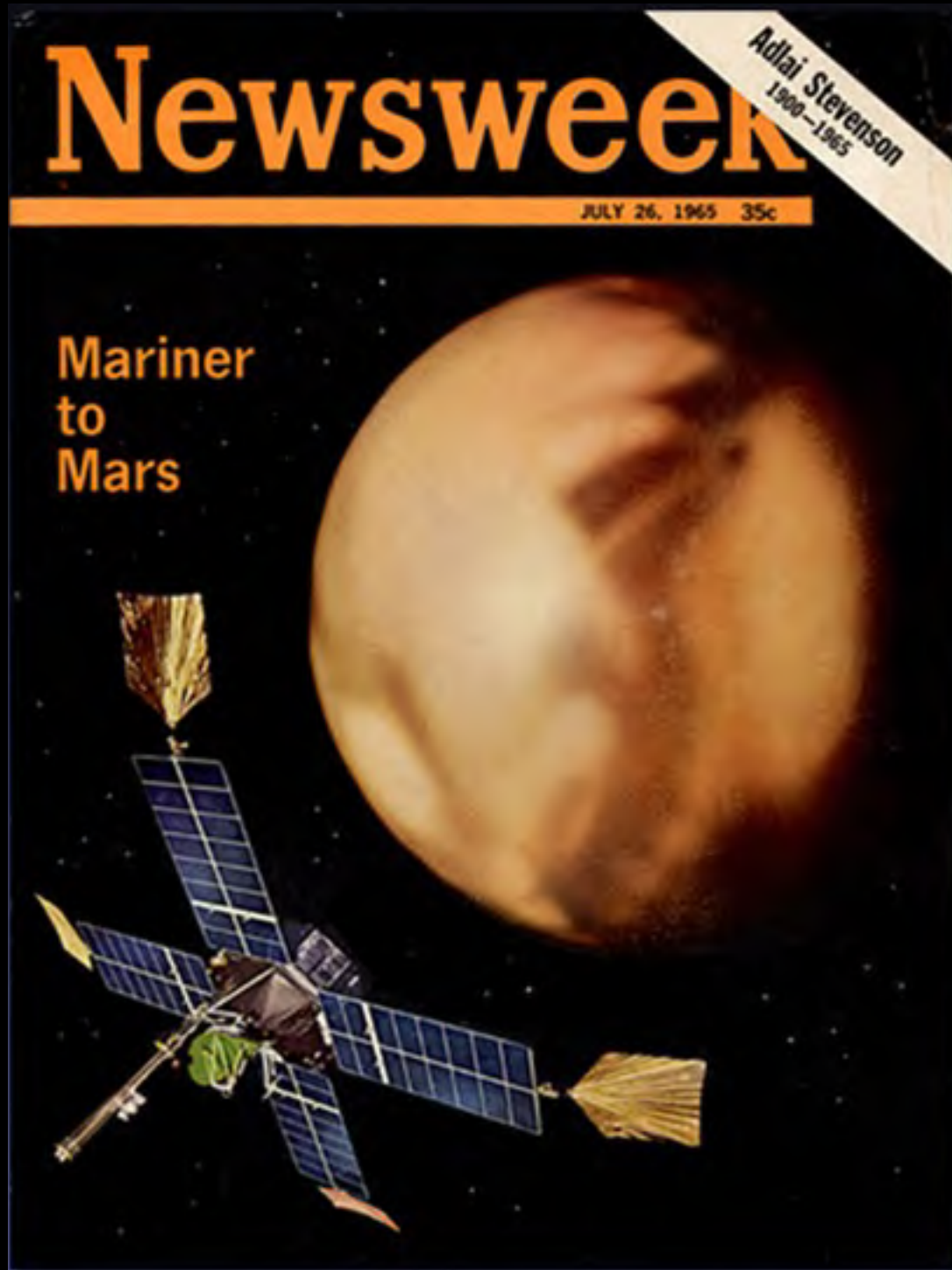
*1954: Martian landscape by artist Chesley Bonestell*



*1956: Superb telescopic photo by Caltech's Robert Leighton using his own mechanical adaptive-optical system*

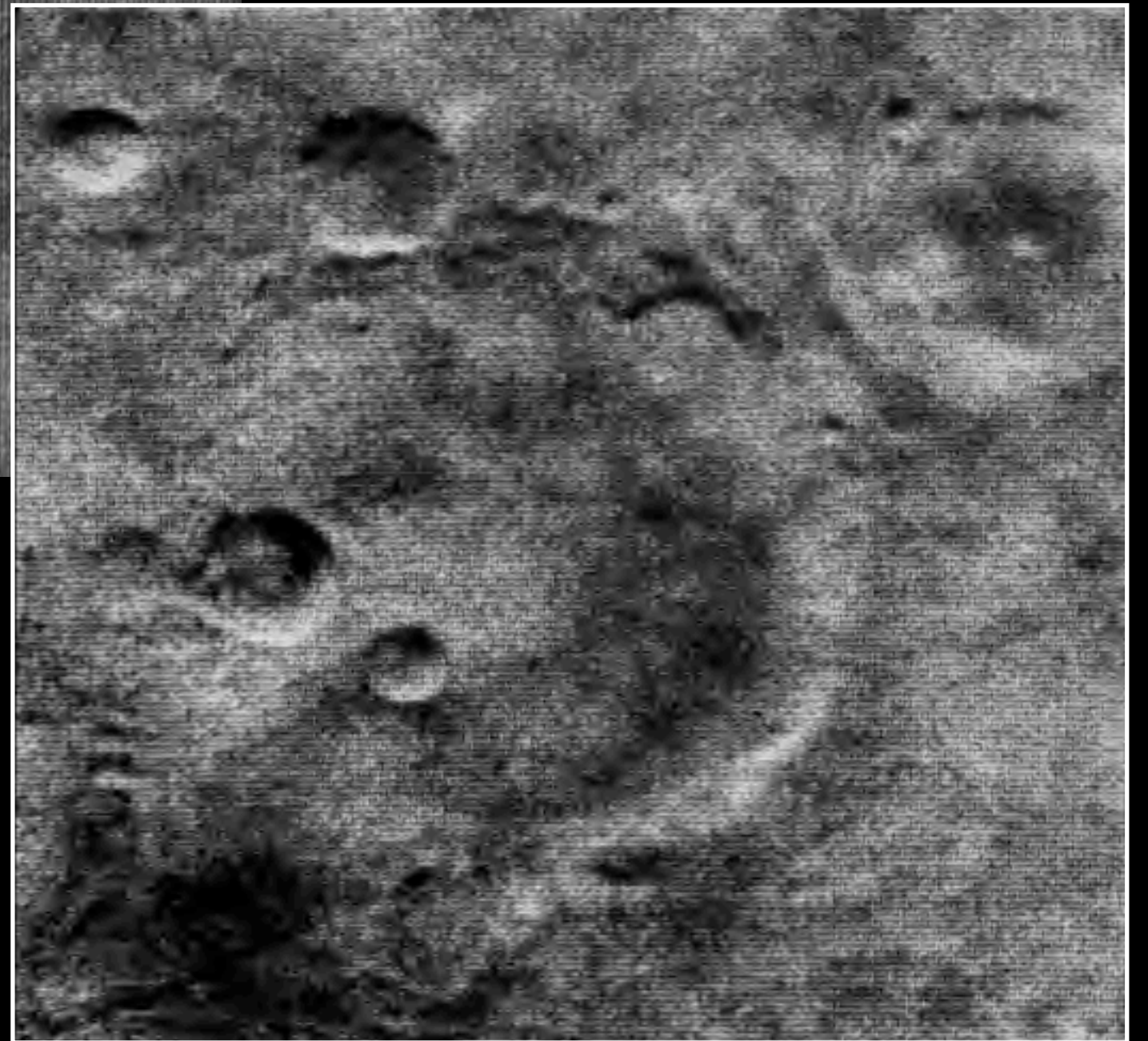
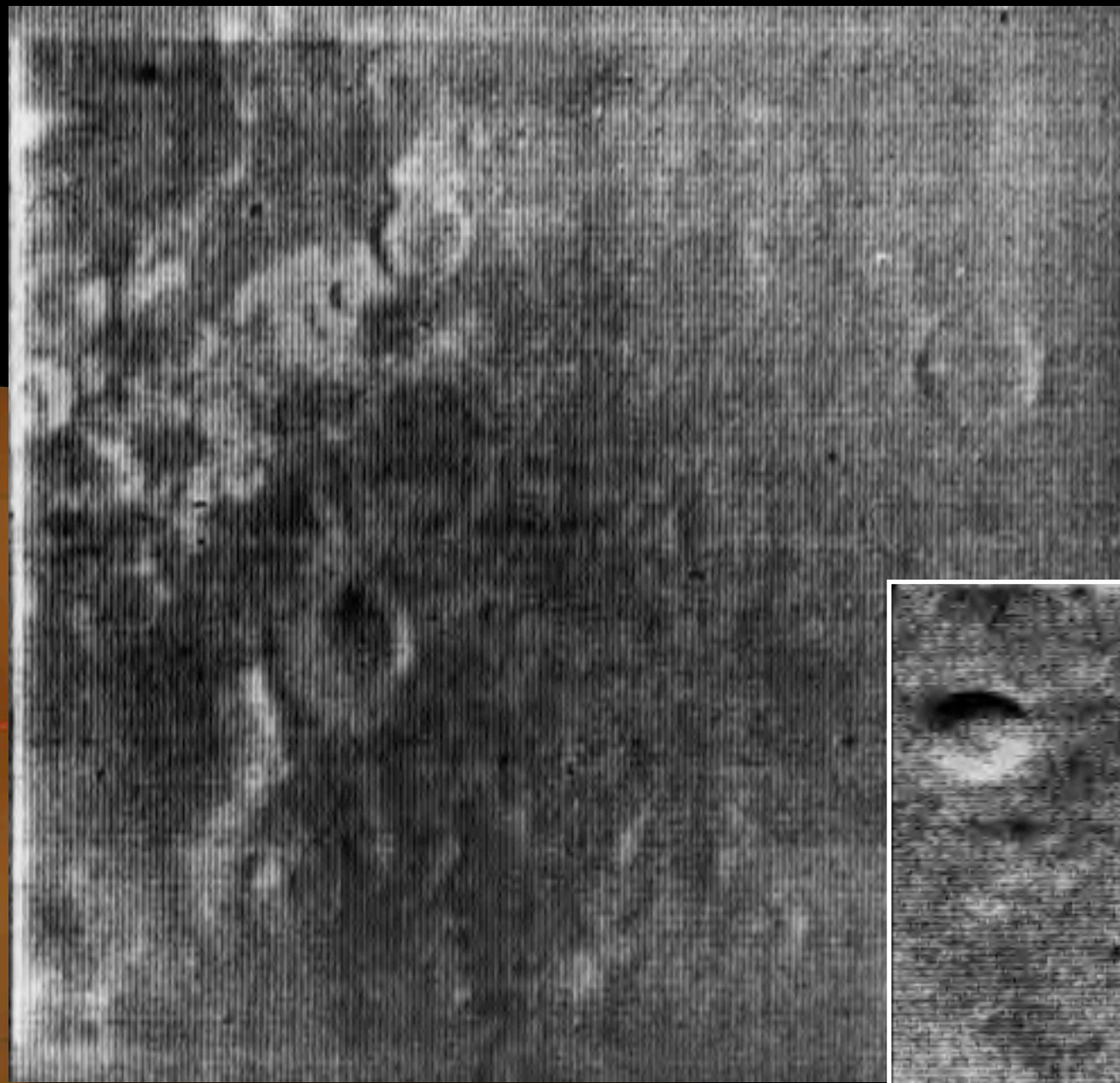
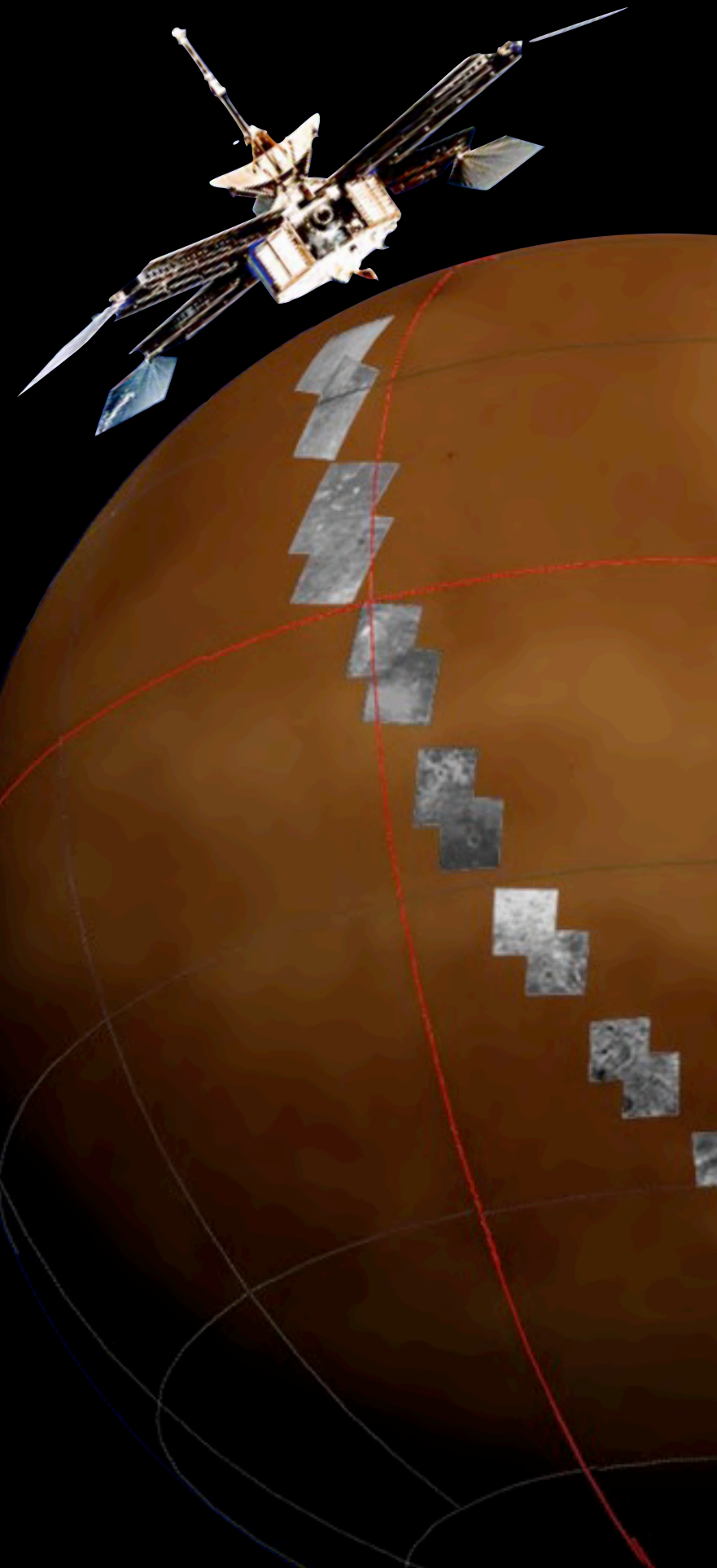


# 1965: Mariner 4





# Craters on Mars







## Mariner 4's Mars: The Dead Planet?

Radio occultation experiment reveals surface pressure of only 0.007 that on Earth -- too low for liquid water to exist

Mars lacks an ozone layer to screen out deadly x-rays and UV

Mariner 4's Mars is a frigid, radiation-bathed desert



# Flight Plan



artwork: Chesley Bonestell







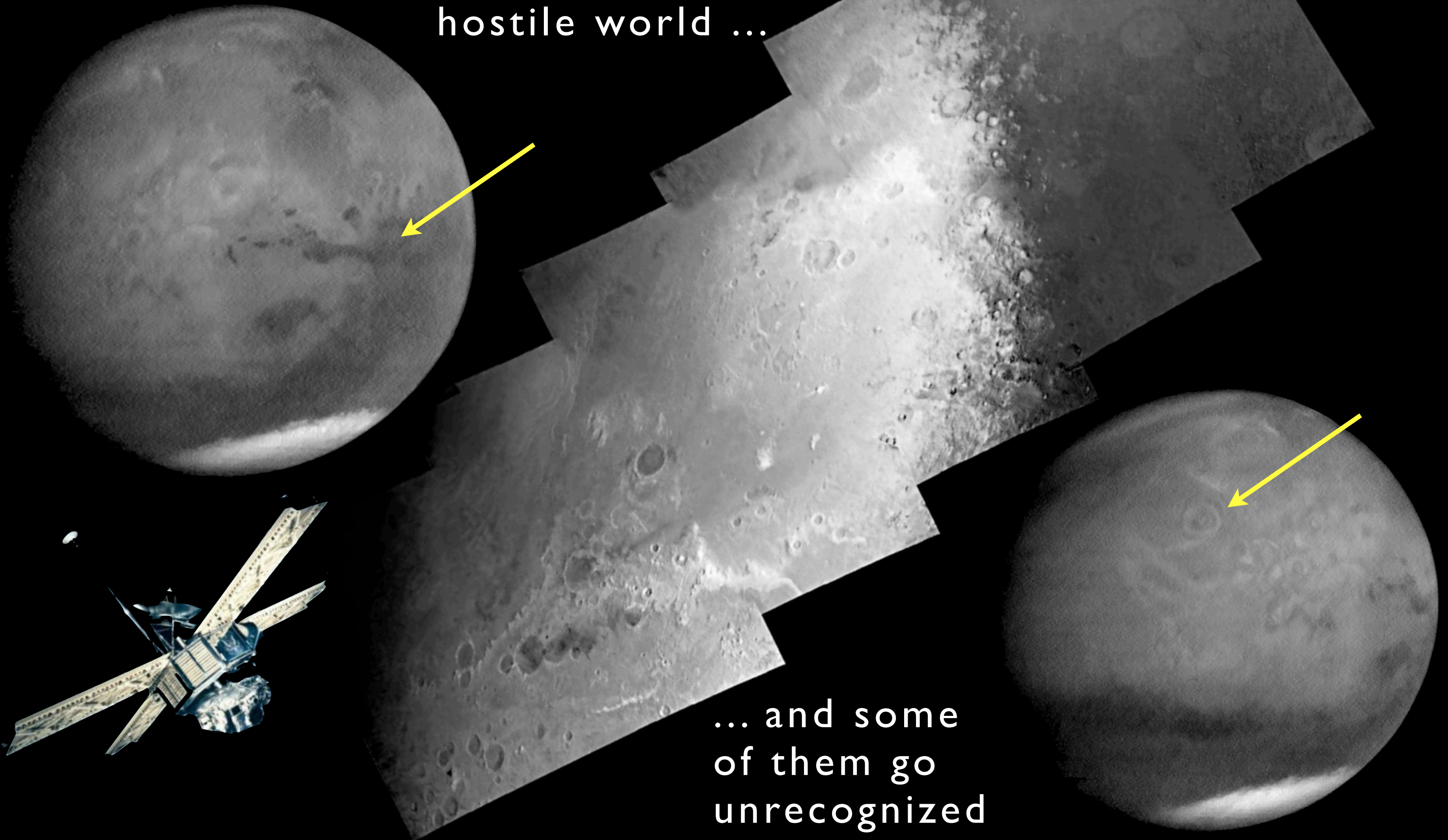


1954

1969



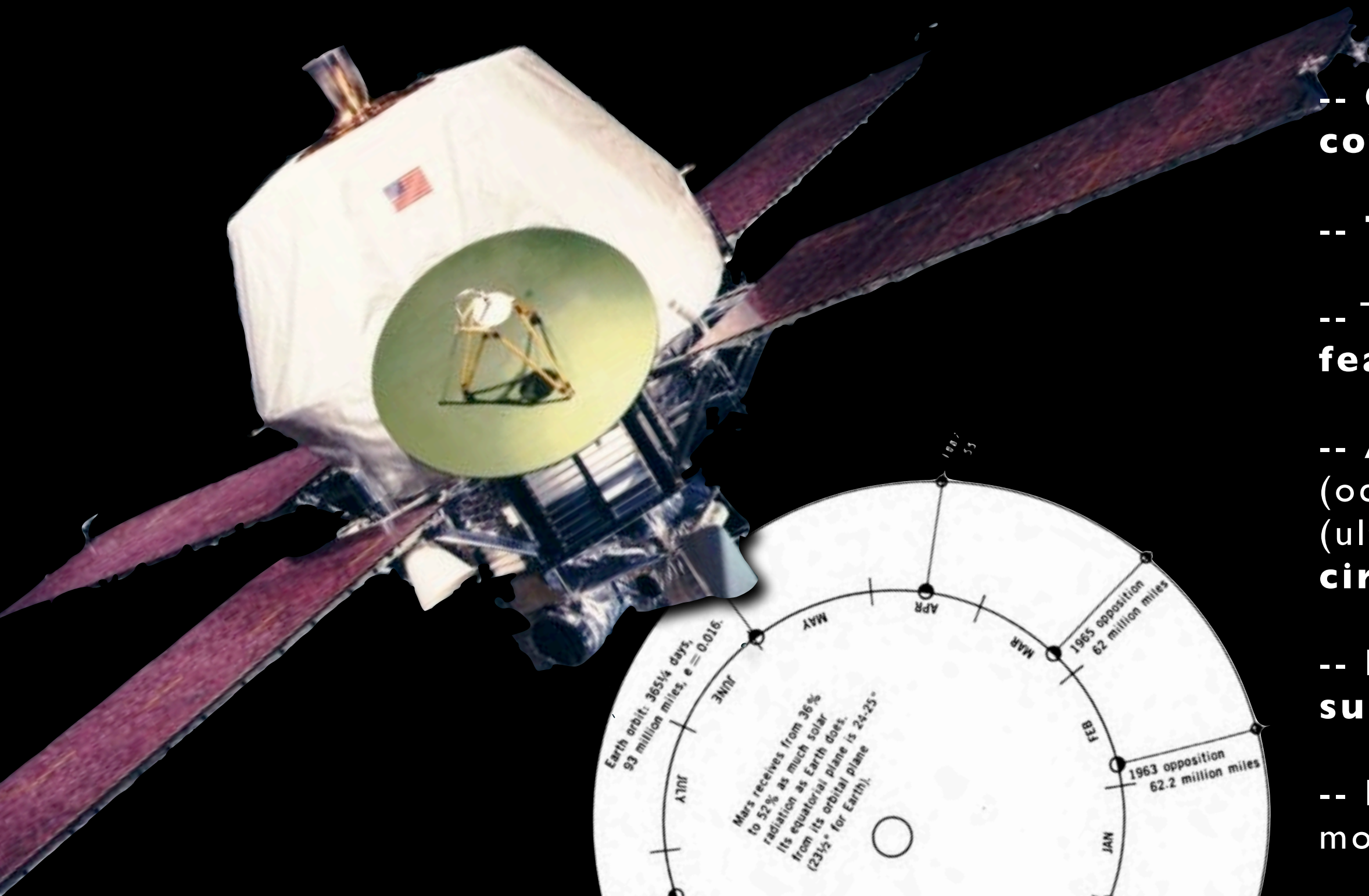
1969: Mariners 6 and 7 give new details of a hostile world ...



... and some of them go unrecognized



# 1971: Mariner 9 is first planetary orbiter



-- **Global photographic coverage**

-- **Topographic data**

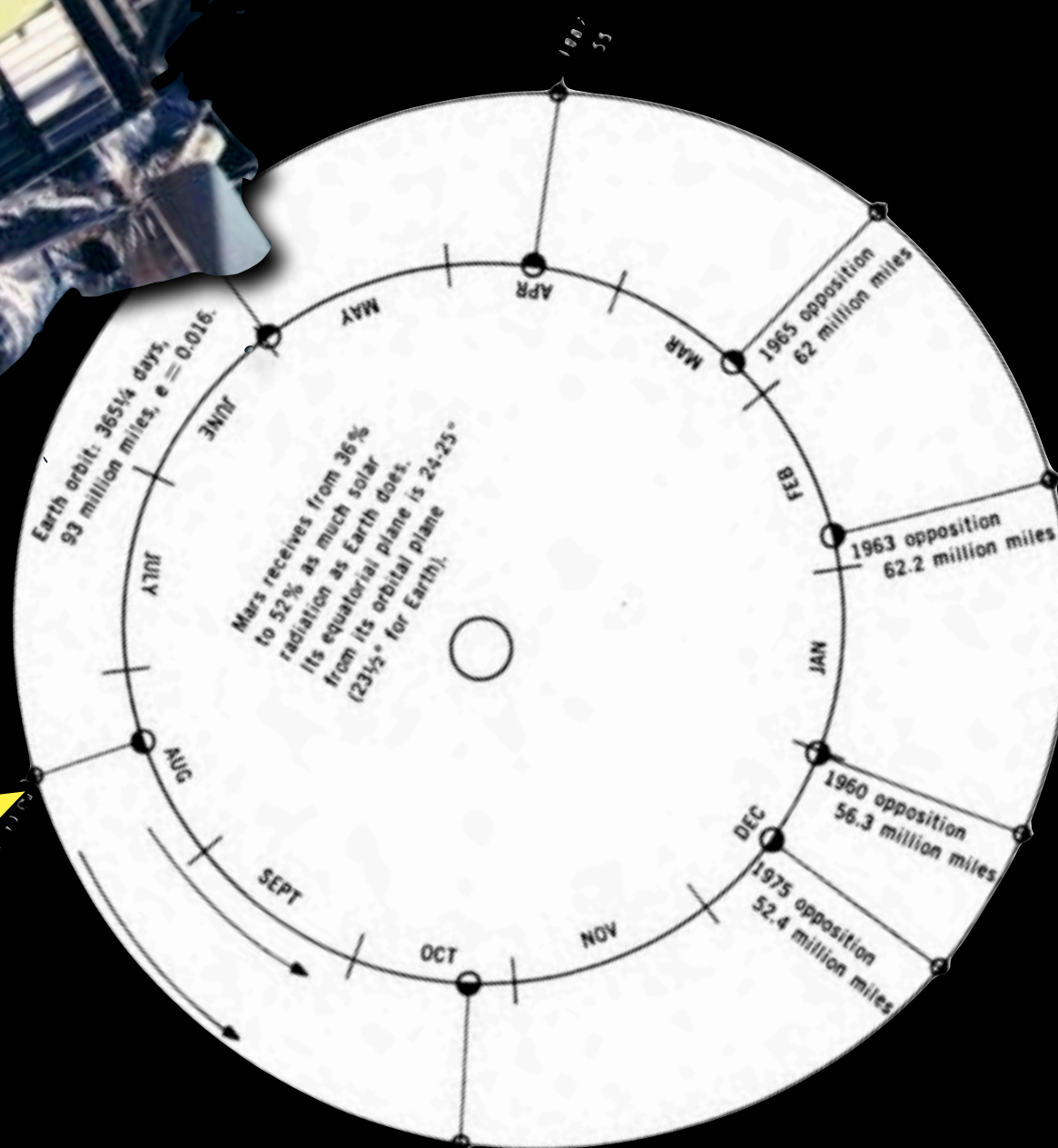
-- Time-study of **variable features**

-- **Atmospheric structure** (occultations), **composition** (ultraviolet spectrometer), **circulation**

-- Infrared measurements for **surface temperatures**

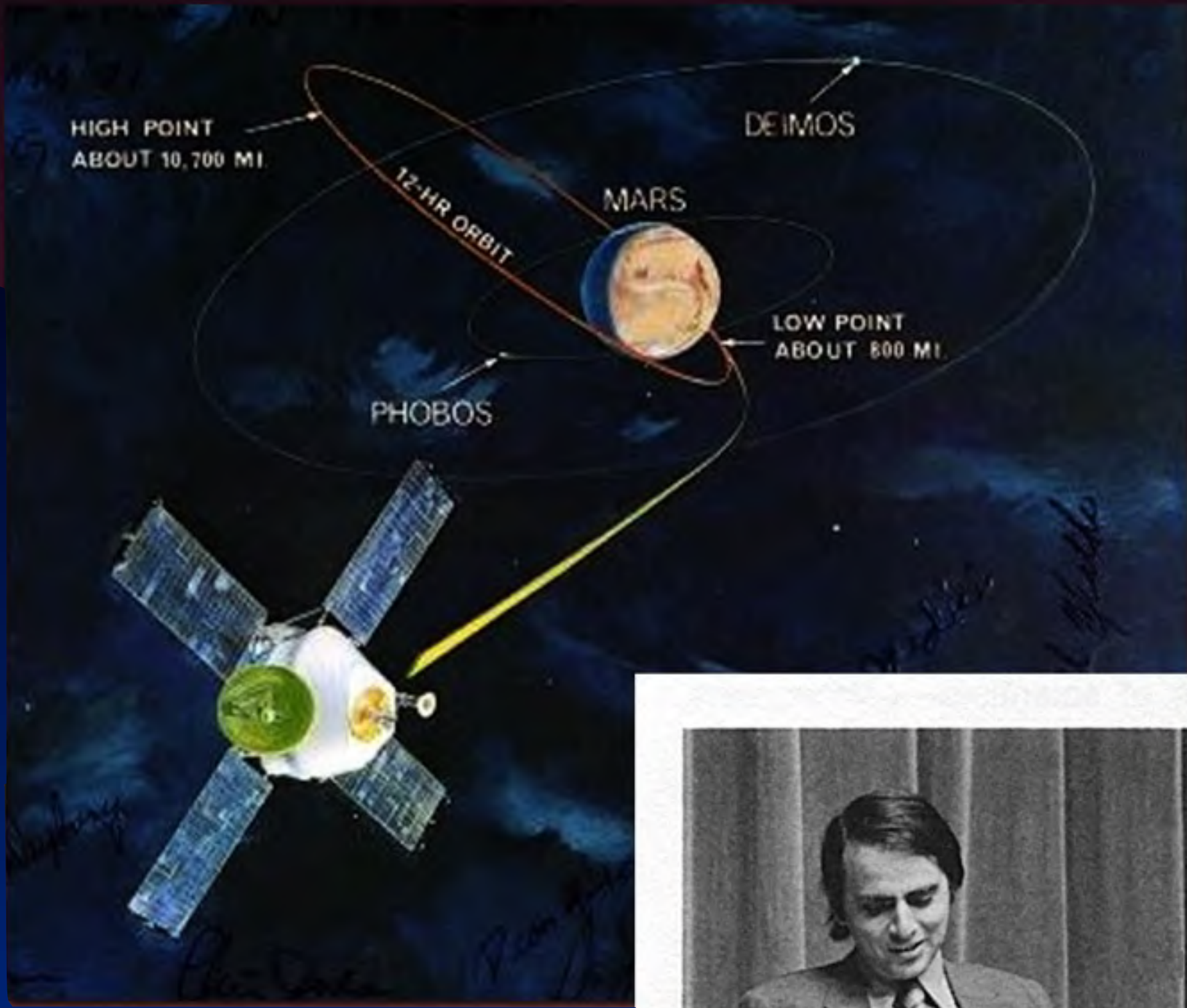
-- First closeups of Martian moons **Phobos and Deimos**

*A close approach and a rare opportunity*



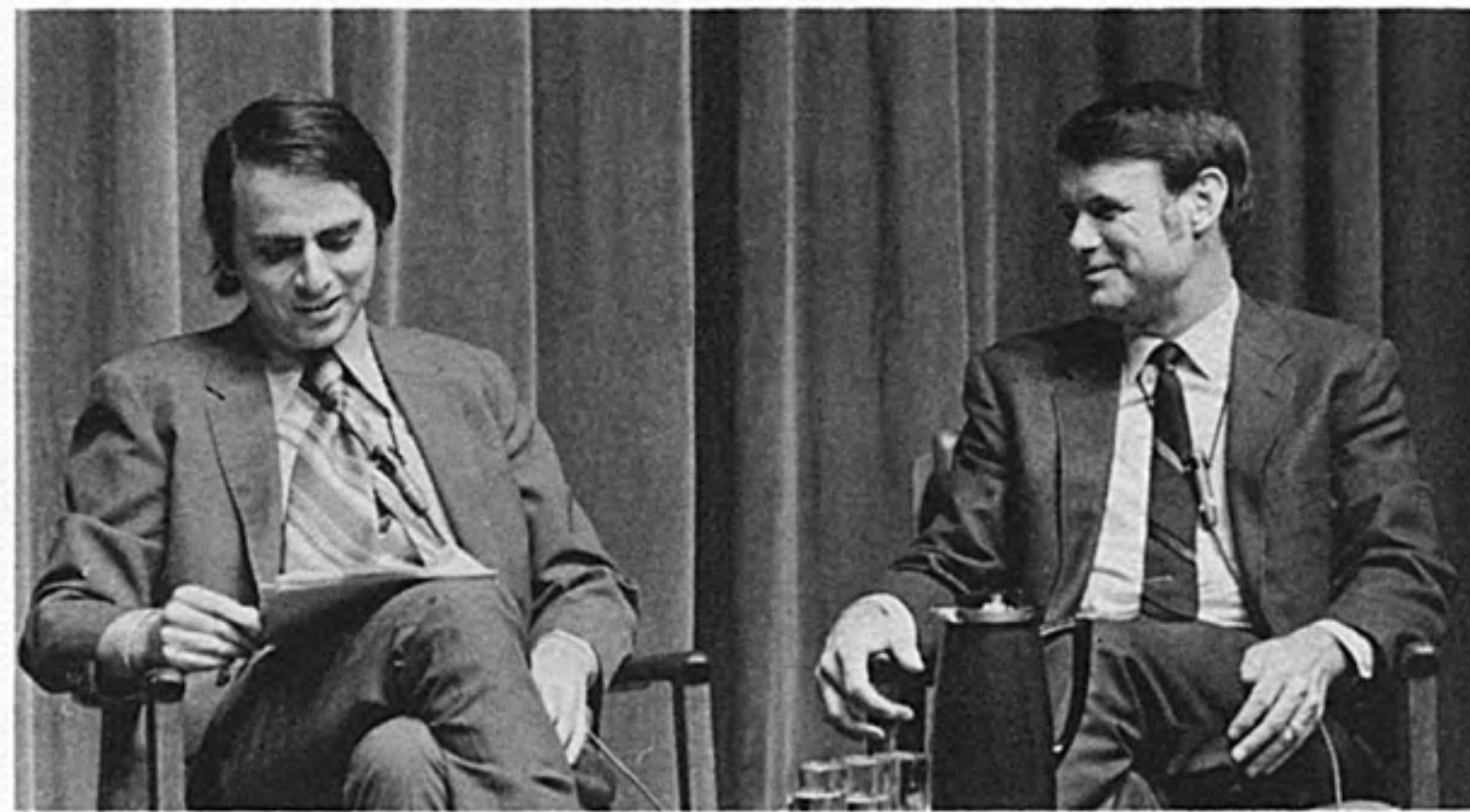
1971 opposition  
34.9 million miles





Clarke

Bradbury



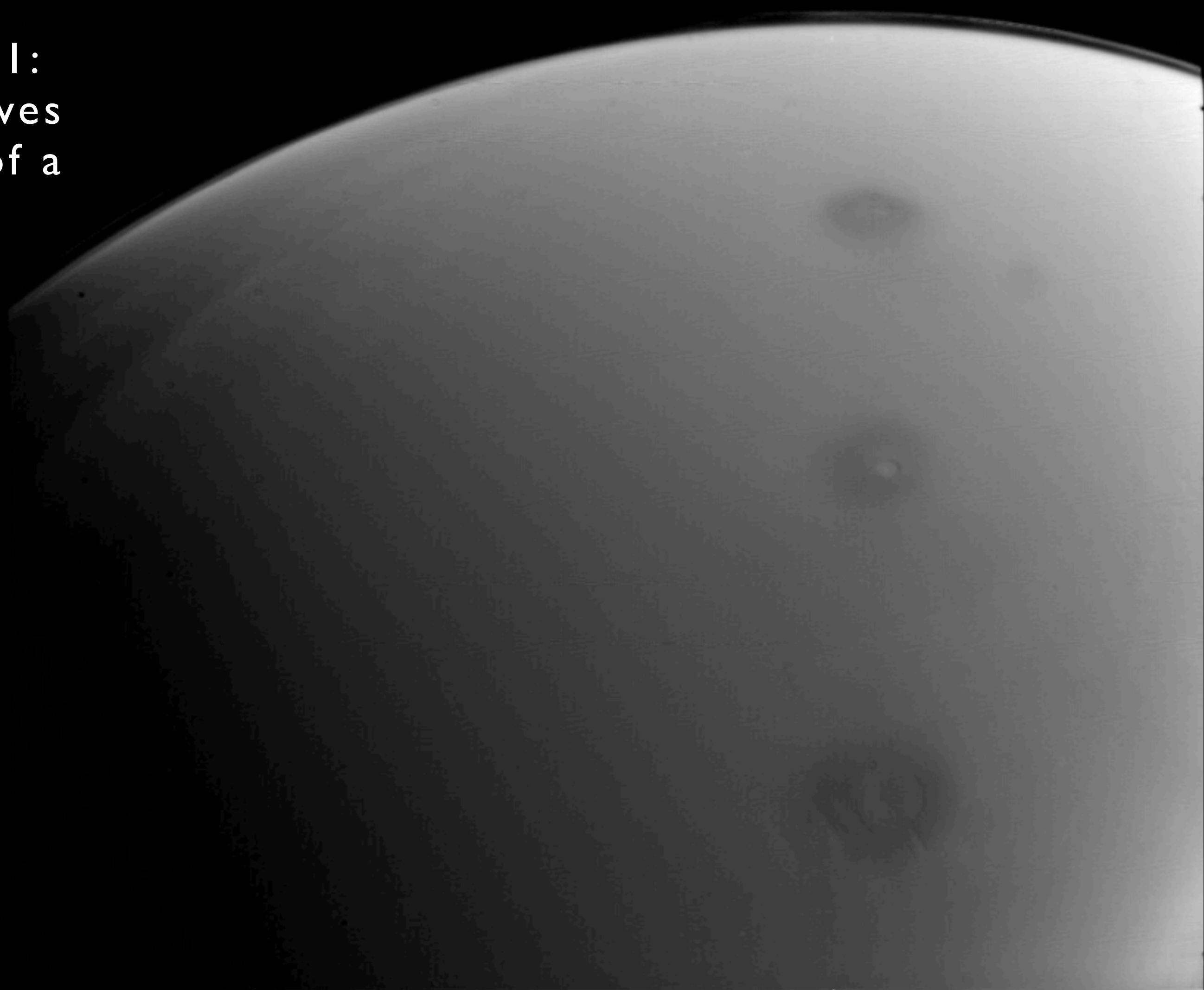
Sagan

Murray

1971

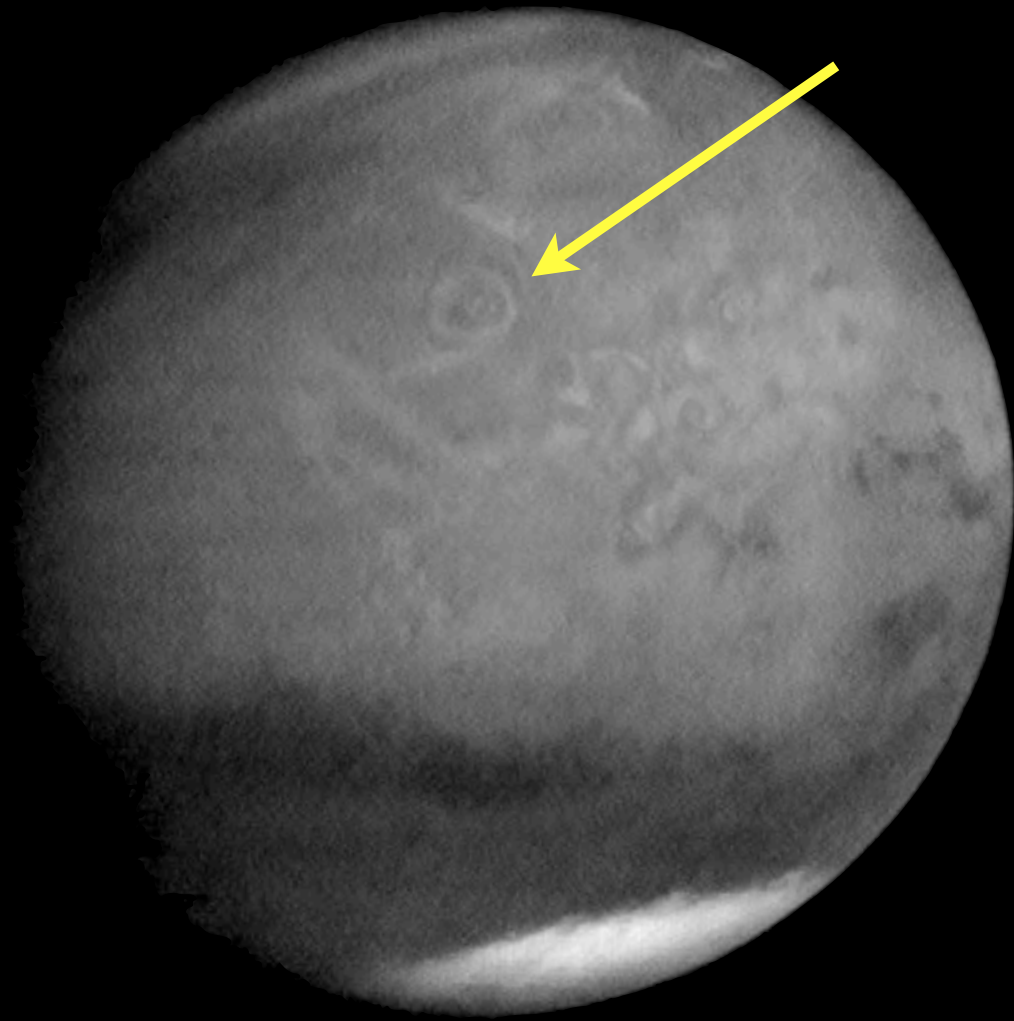


November 1971:  
Mariner 9 arrives  
at the height of a  
global dust  
storm



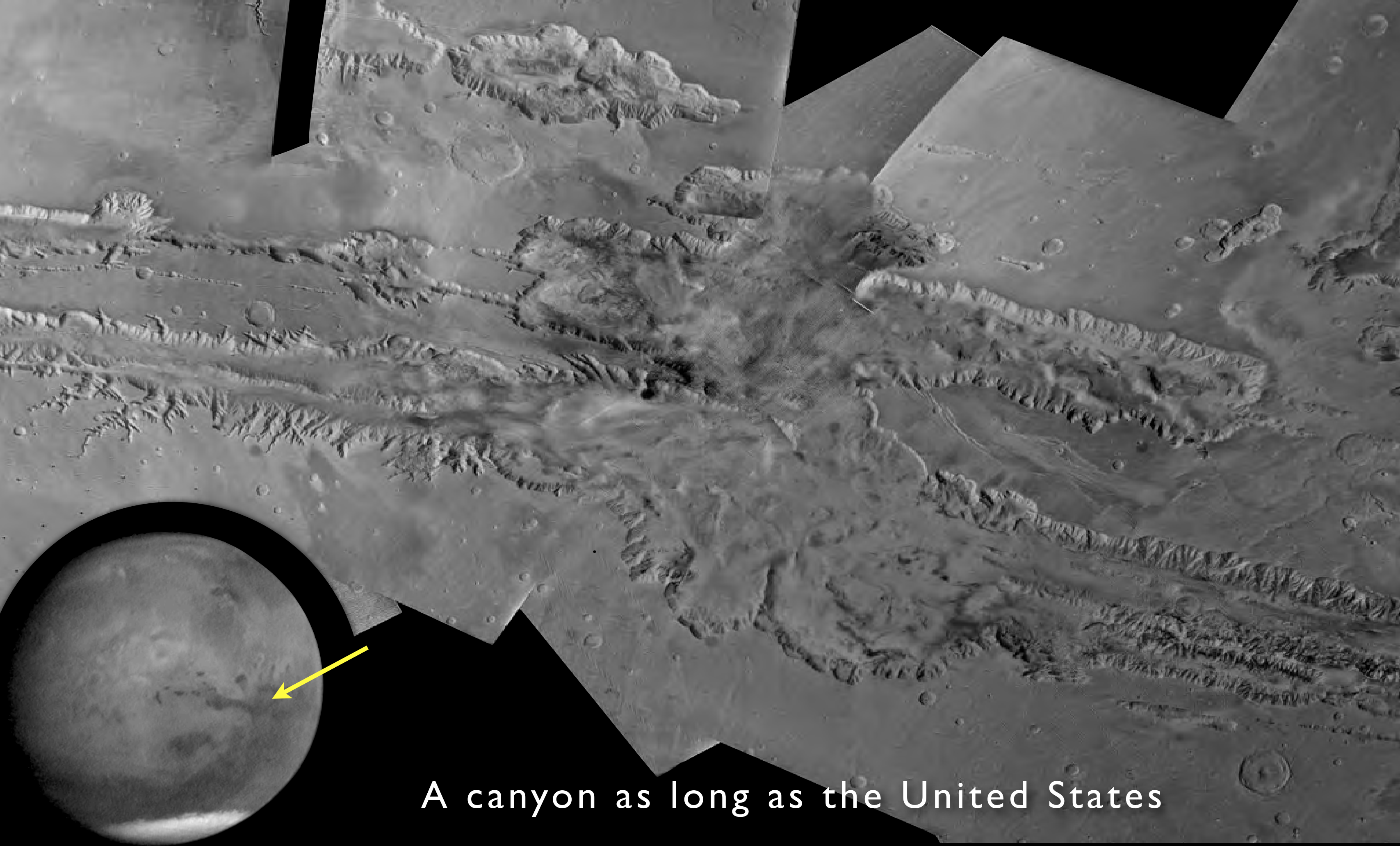


A volcano as big as  
Arizona, 3x higher  
than Everest



*Olympus Mons*

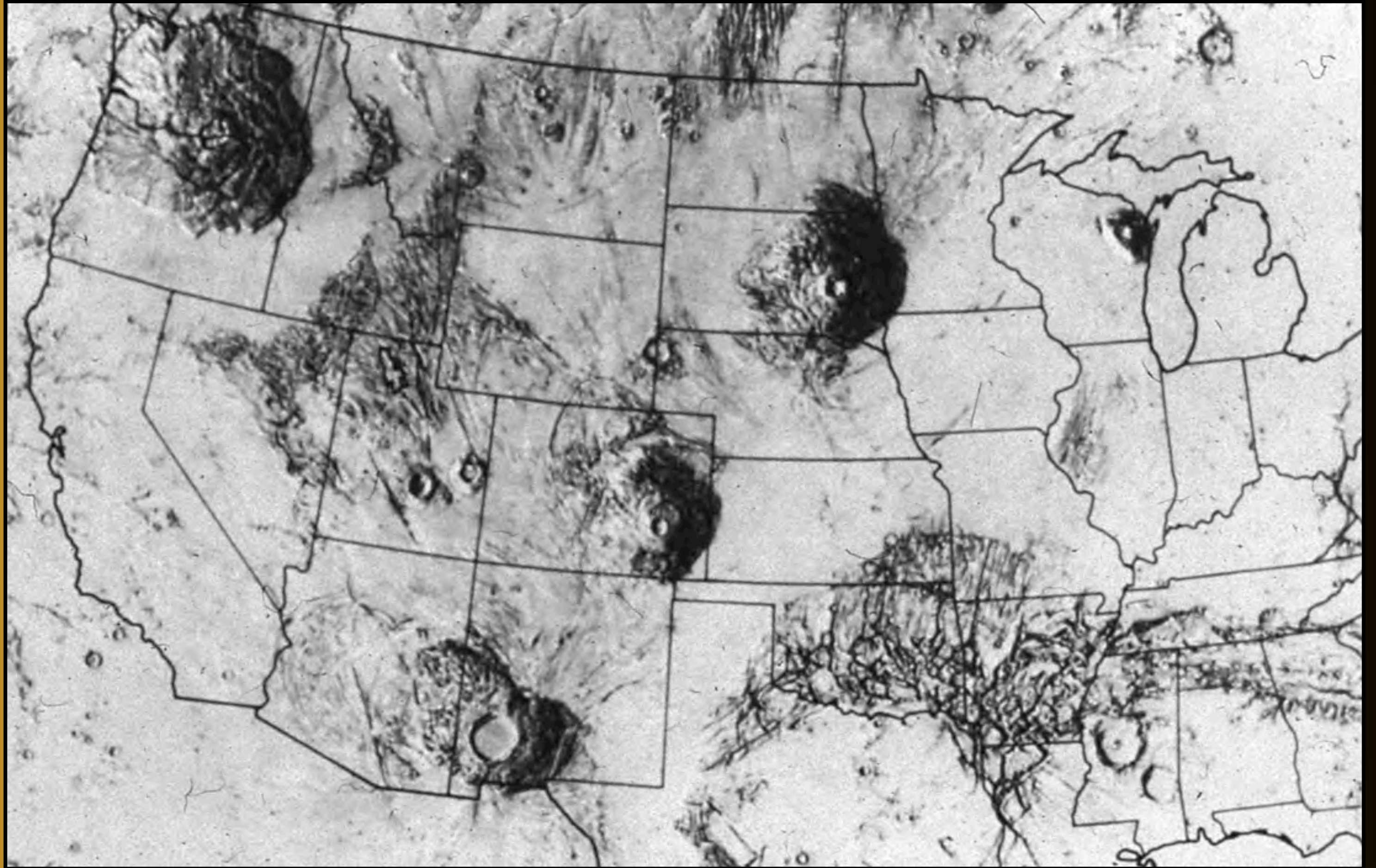




A canyon as long as the United States



# Titanic landforms on a world half the size of Earth







Telltale clues  
to an ancient,  
watery past ...

*Ma'adim Vallis, a  
550-mile-long  
channel in the  
Martian southern  
highlands*

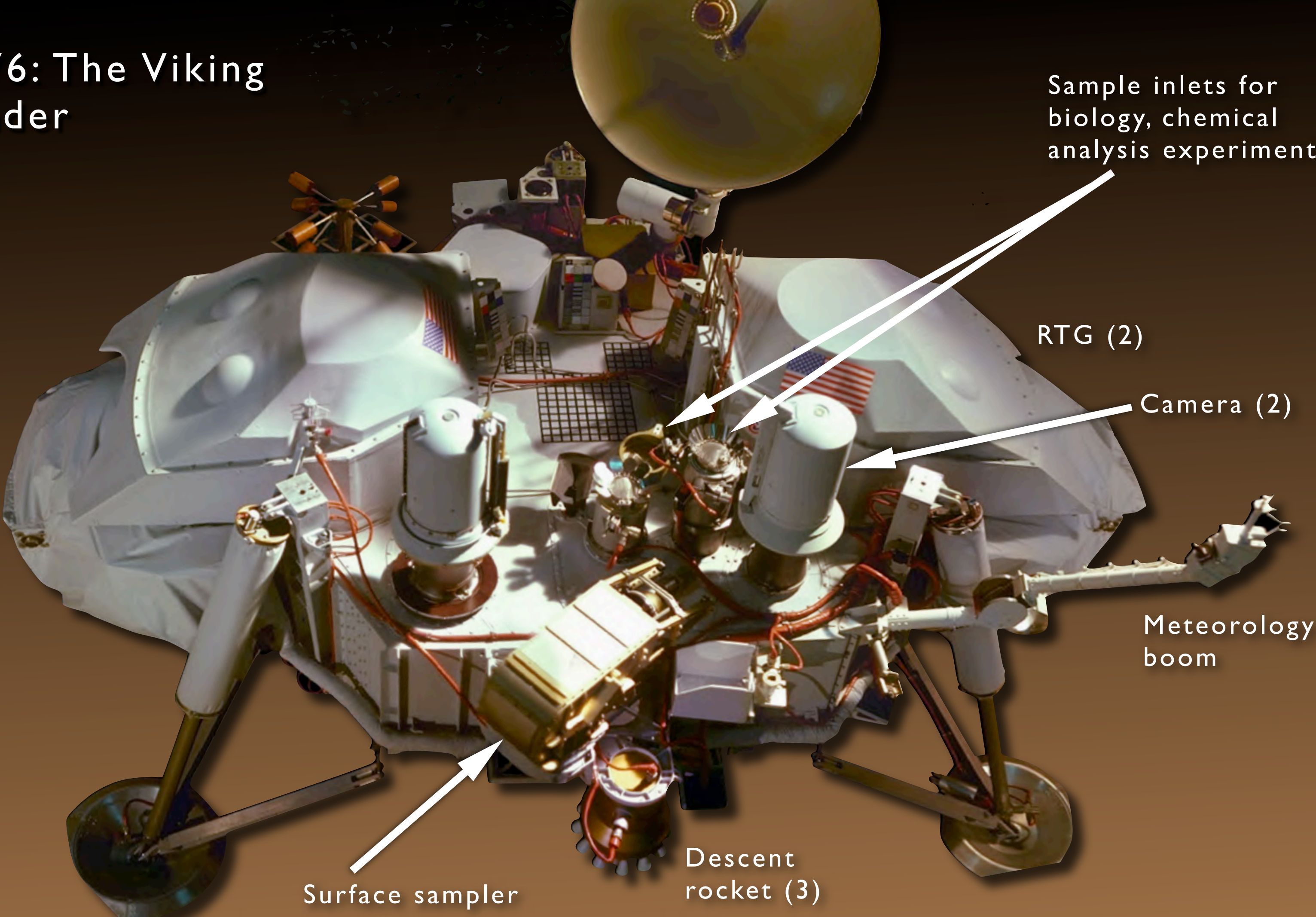


... and a “history book”  
of Martian climate

*Layers of dust and ice near  
the Martian south pole  
(thinnest layers visible here  
are 150 feet thick)*



# 1976: The Viking Lander



Sample inlets for biology, chemical analysis experiments

RTG (2)

Camera (2)

Meteorology boom

Descent rocket (3)

Surface sampler



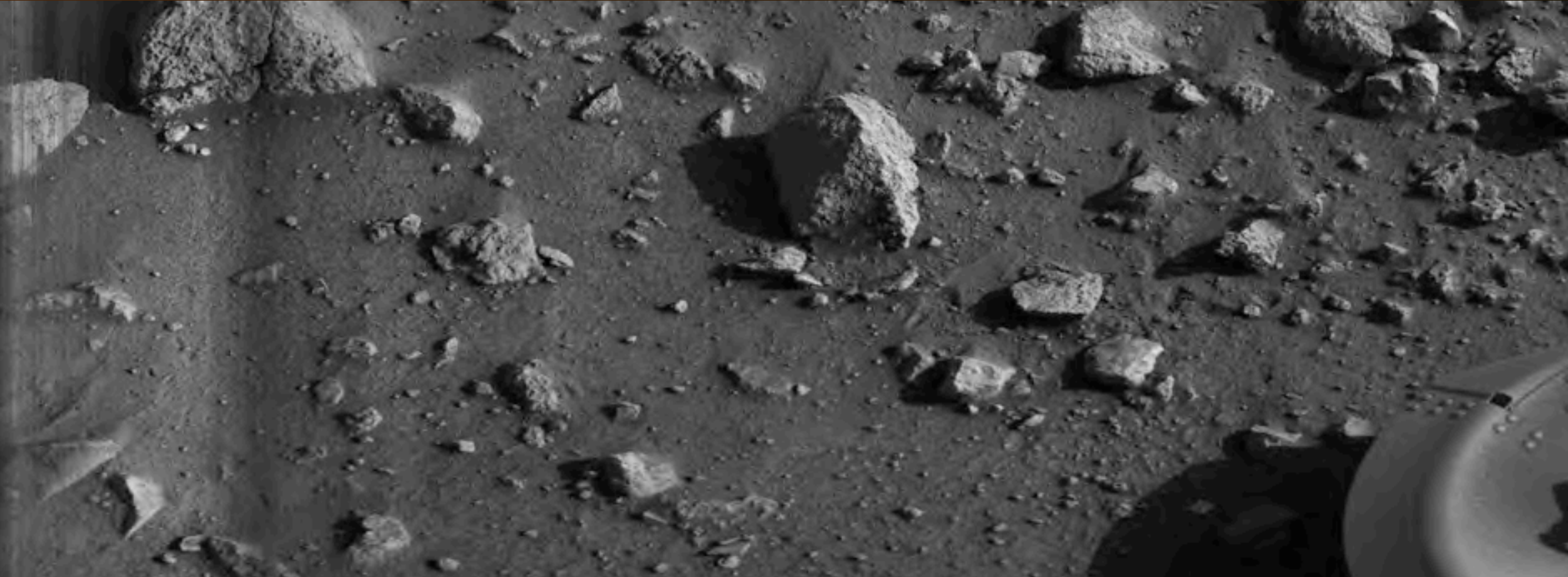


# The Explorer



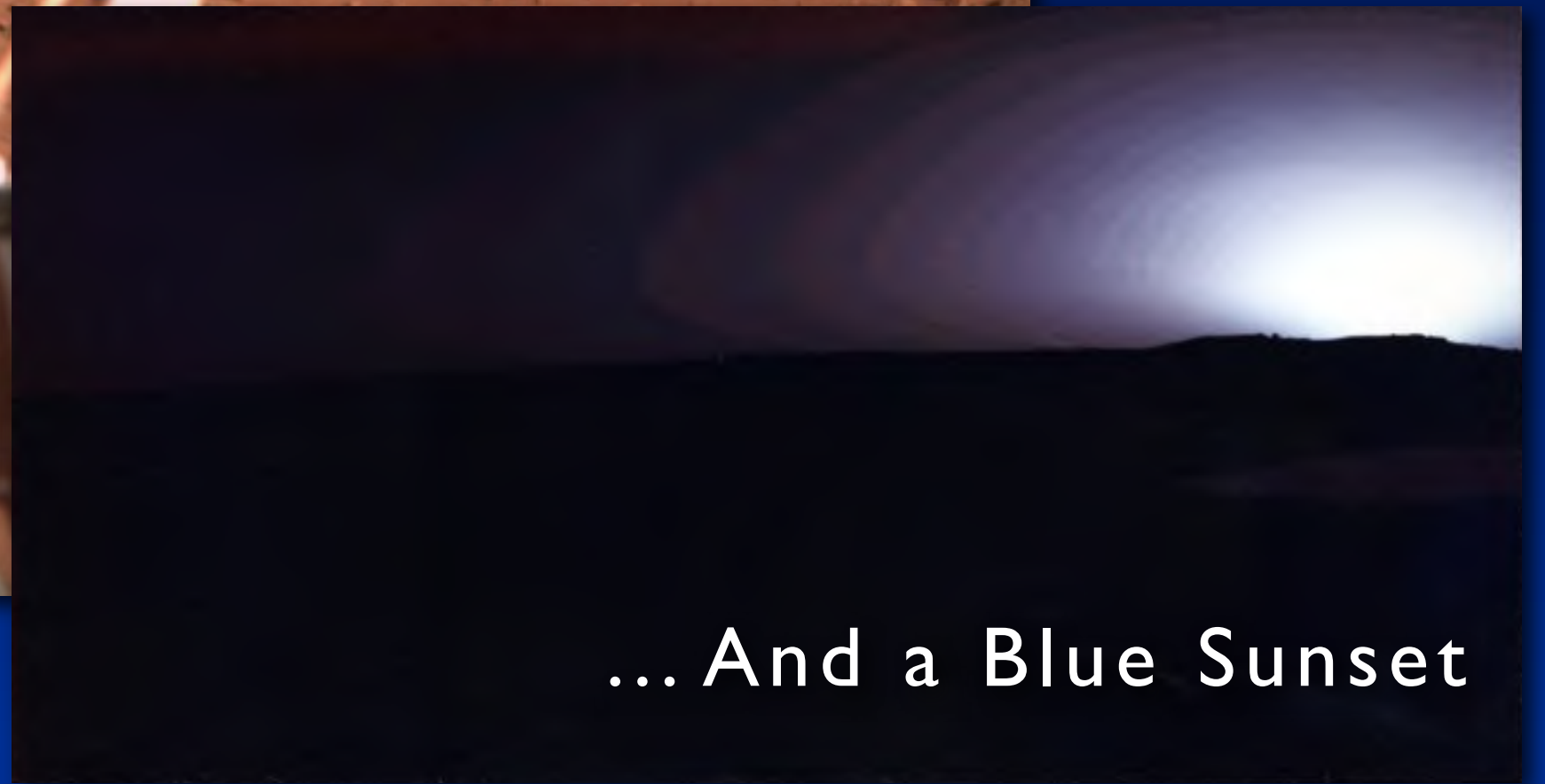


# Rocks on Mars ...





A Red World ...

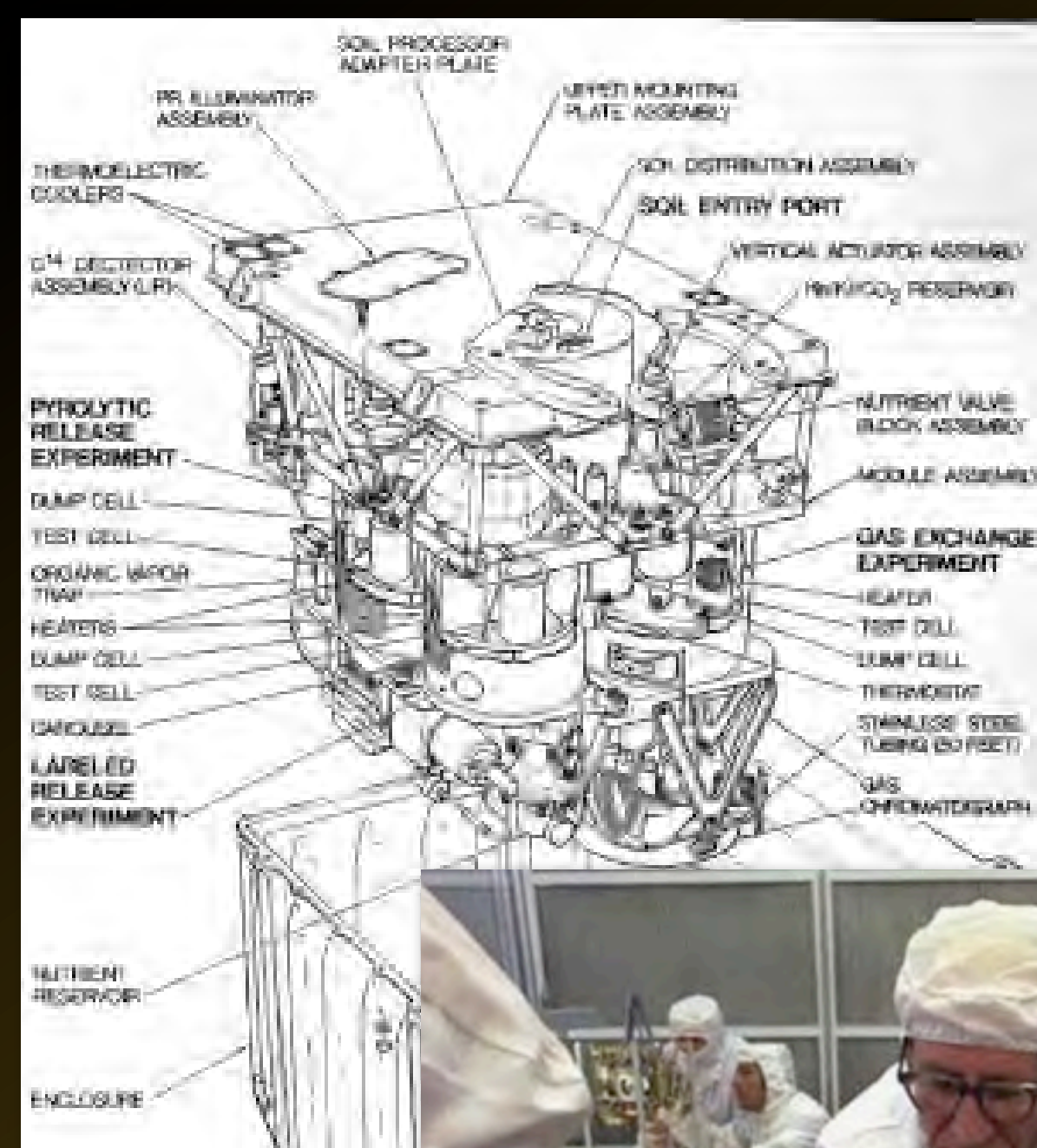


... And a Blue Sunset

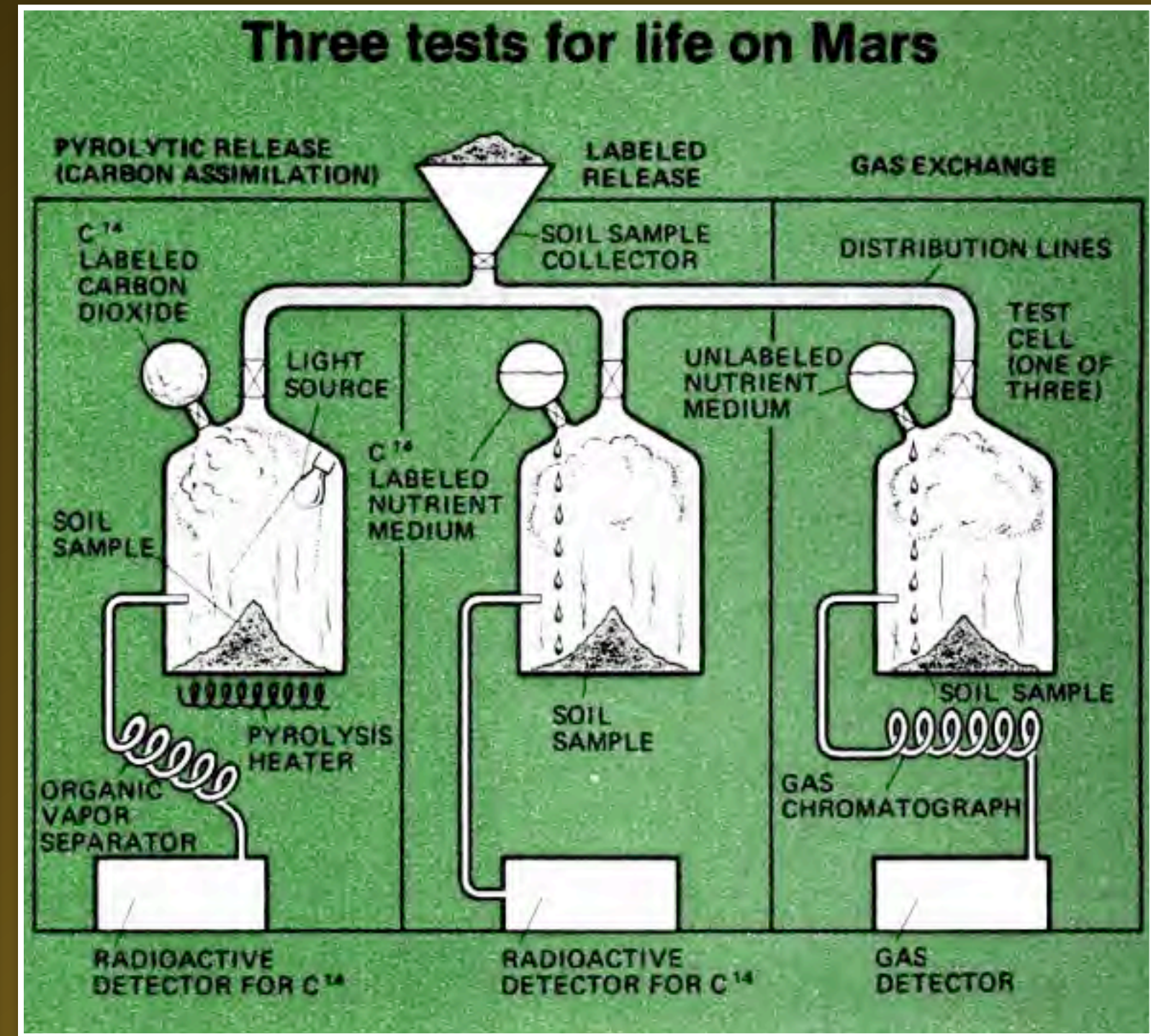


# Searching for life on another planet

- Experiments designed to look for signs of metabolic activity
- With respect to water, a “Goldilocks” approach



Viking biology package at TRW



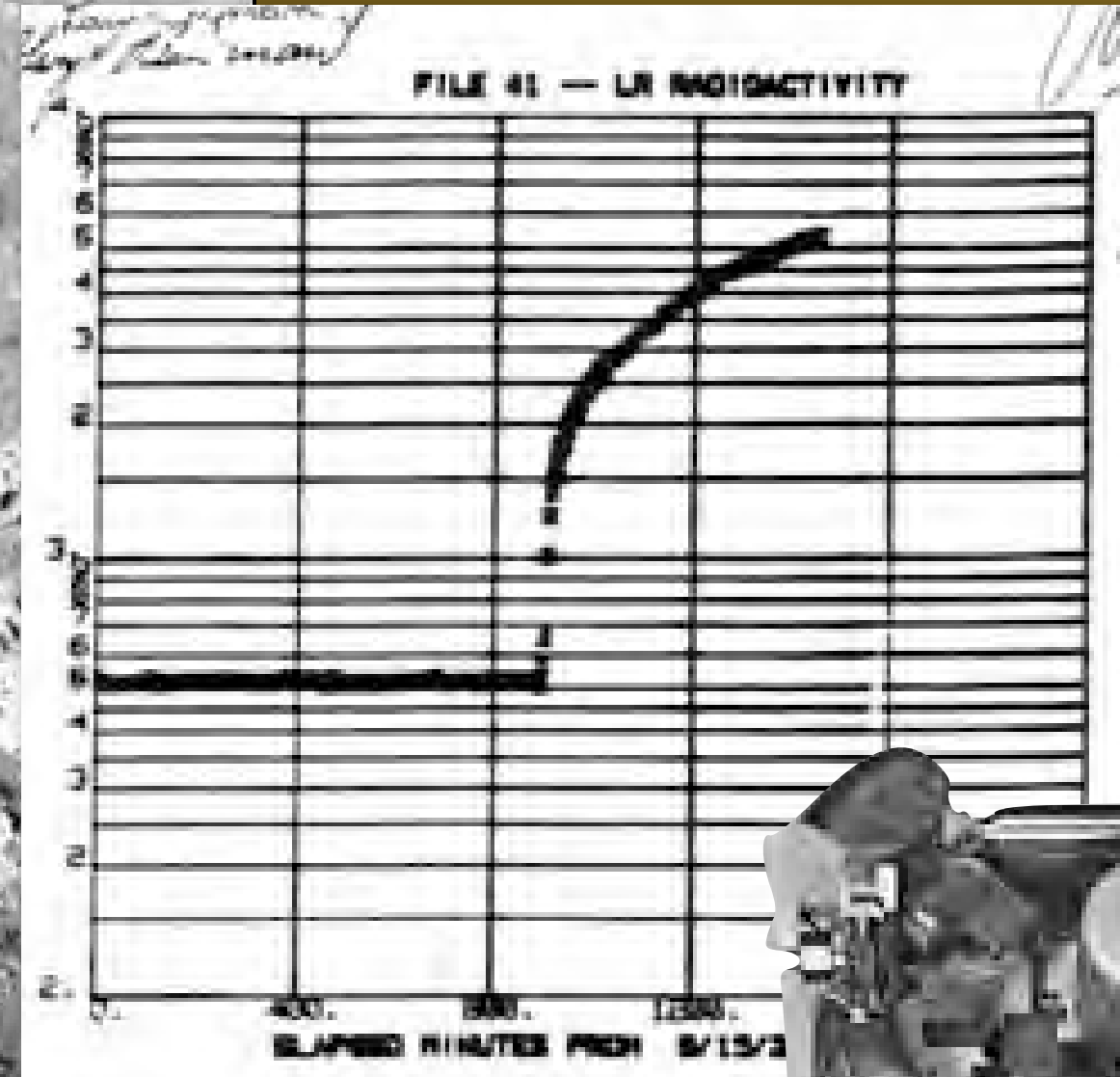
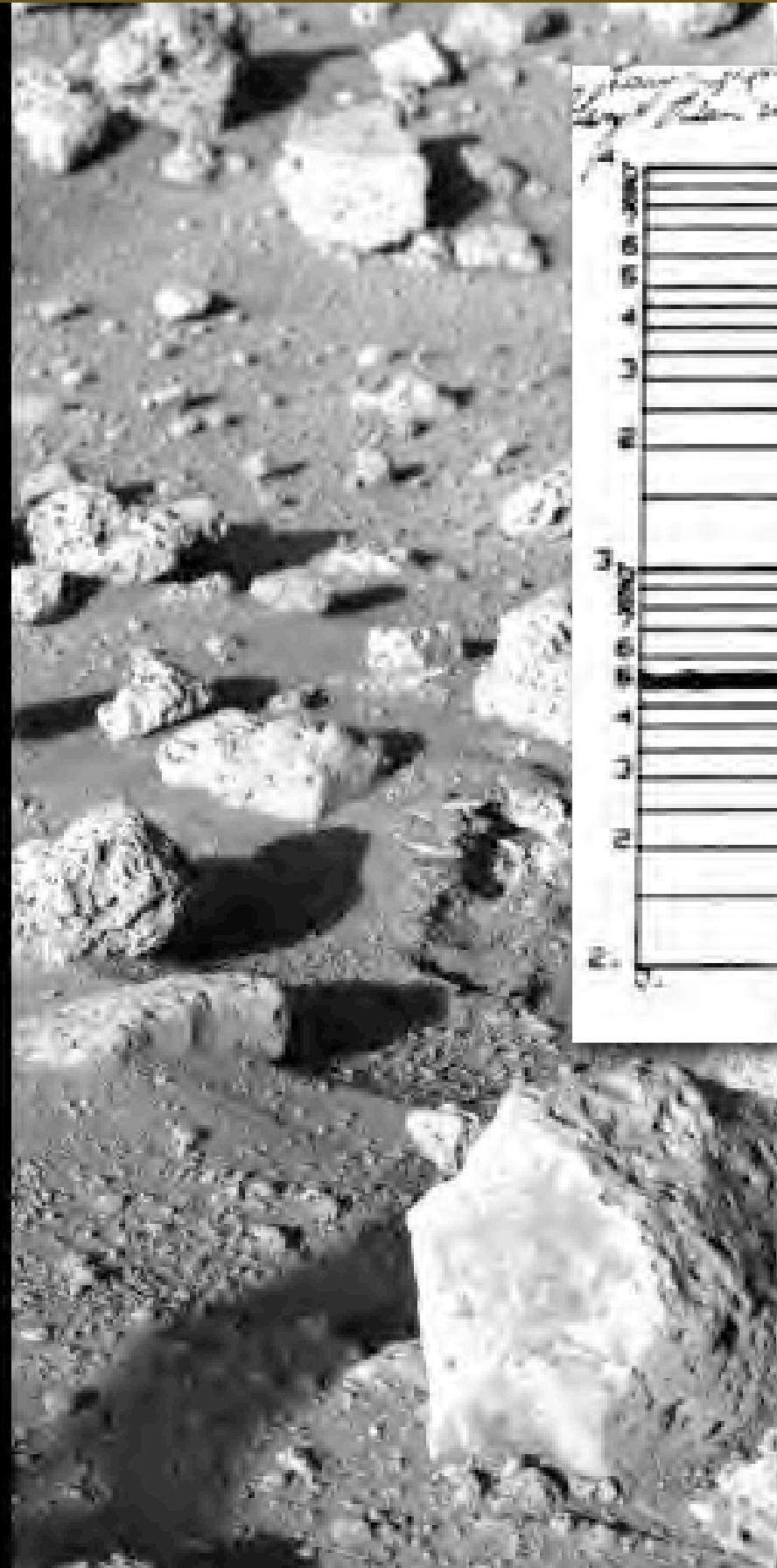
(diagram: Popular Mechanics)



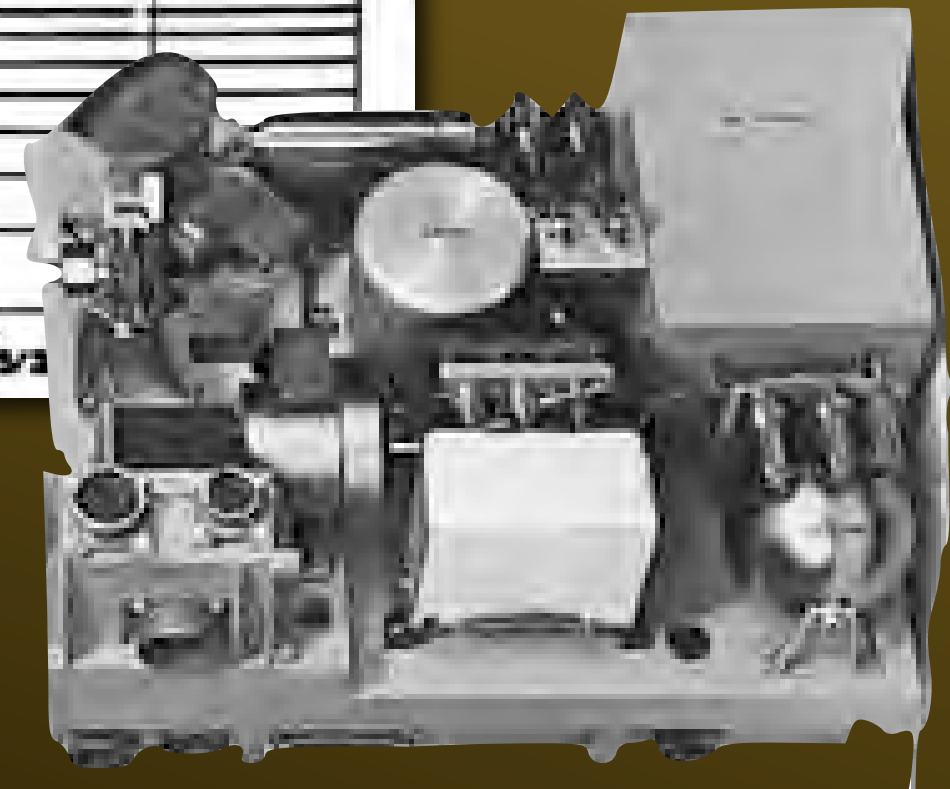
# The surprising biology results



*Sampling under a rock*



*Labeled Release data, July 30, 1976*



*Viking Gas Chromatograph / Mass Spectrometer (GCMS)*



# Viking's search for life: A reach too far

## Vikings Unable to Settle Life-on-Mars Debate

BY GEORGE ALEXANDER

Back in the early 1960s, when the first Viking spacecraft were launched to Mars, there was a great deal of excitement about the possibility of life on the Red Planet. Some would be surprised to learn that the Viking spacecraft have not yet found any evidence of life on Mars.

That excitement remains unfulfilled.

There is a consensus that at least the Viking spacecraft have not found any evidence of life on Mars. Some scientists, however, believe that the Viking spacecraft have not yet found any evidence of life on Mars.

Others, however, believe that the Viking spacecraft have not yet found any evidence of life on Mars. Some scientists, however, believe that the Viking spacecraft have not yet found any evidence of life on Mars.

When the Viking spacecraft were launched, there was a great deal of excitement about the possibility of life on the Red Planet. Some would be surprised to learn that the Viking spacecraft have not yet found any evidence of life on Mars.



PROGRESS REPORT—Biologist Norman H. Horowitz discusses results of pyrolytic release experiments aboard Viking spacecraft on Mars. Behind him is a wiring diagram of experiment. Times photo by Rick

July, but they also were made suspicious by a "wet" soil, as Klein and others were to say in identical words, "too much, too soon."

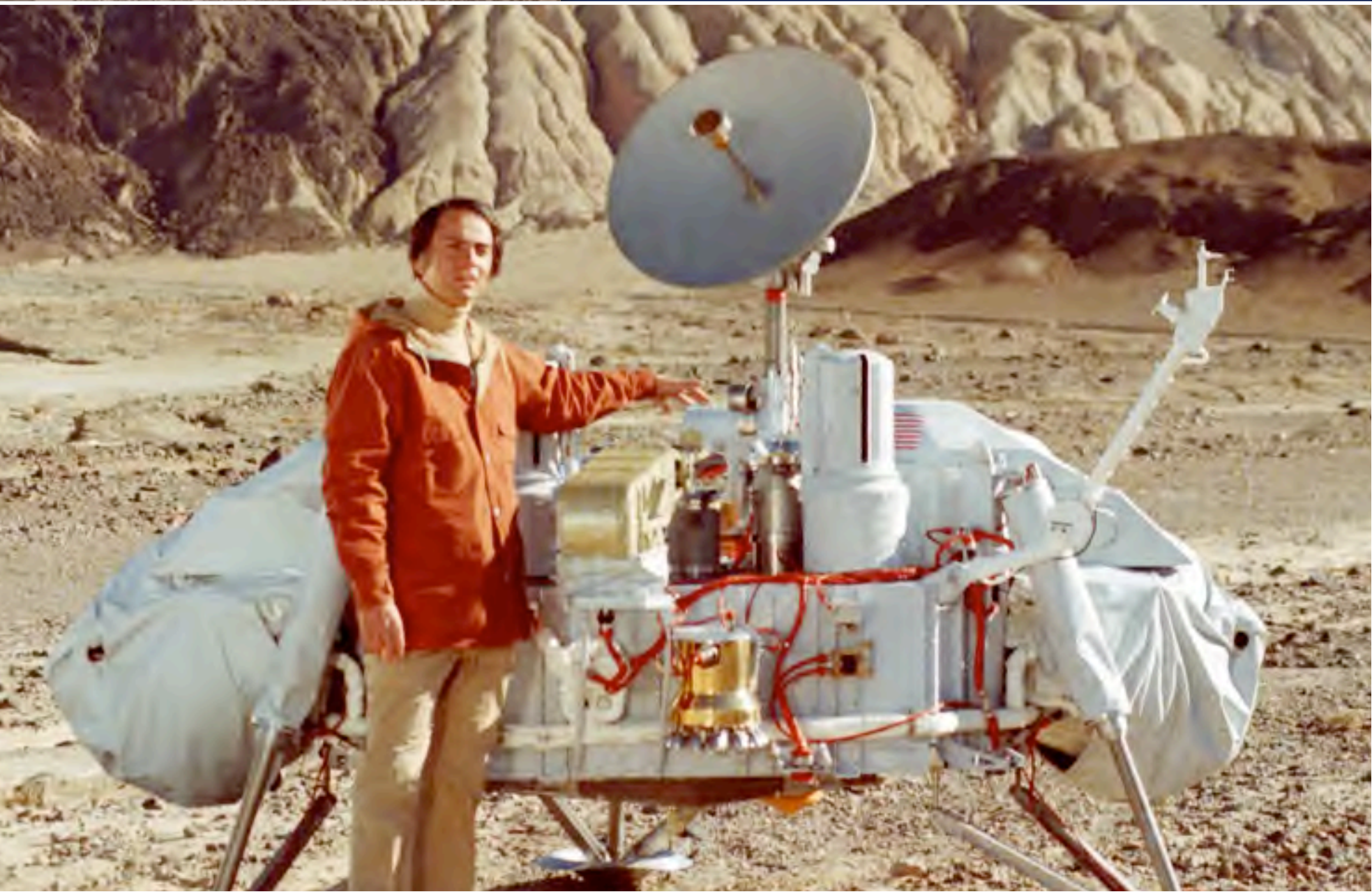
They also were a little leery of the slow, steady production of carbon dioxide gas from the sample, which had been incubating in the Viking 1 test cell for roughly two months now. "Some of the cracked setup is apparently being oxidized by something in the soil," Klein said. "It looks like a slow, continuing chemical reaction."

Both oxygen and carbon dioxide

Los Angeles  
**Times**  
CC PART II  
WEDNESDAY, OCTOBER 6, 1976

*"What I would wish for you is an increased tolerance for ambiguity."*

-- Carl Sagan



Los Angeles Times, October 6, 1976





NASA  
National Aeronautics and  
Space Administration

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Thomas A. Mutch Memorial Station

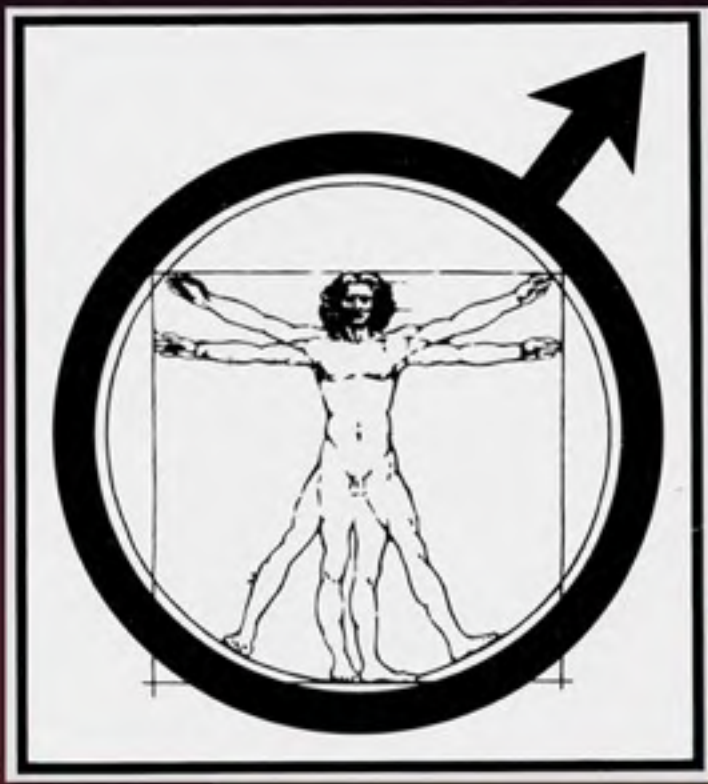
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*Dedicated to the memory of Tim Mutch  
whose imagination, nerve and resolve  
contributed greatly to the exploration  
of the solar system.*

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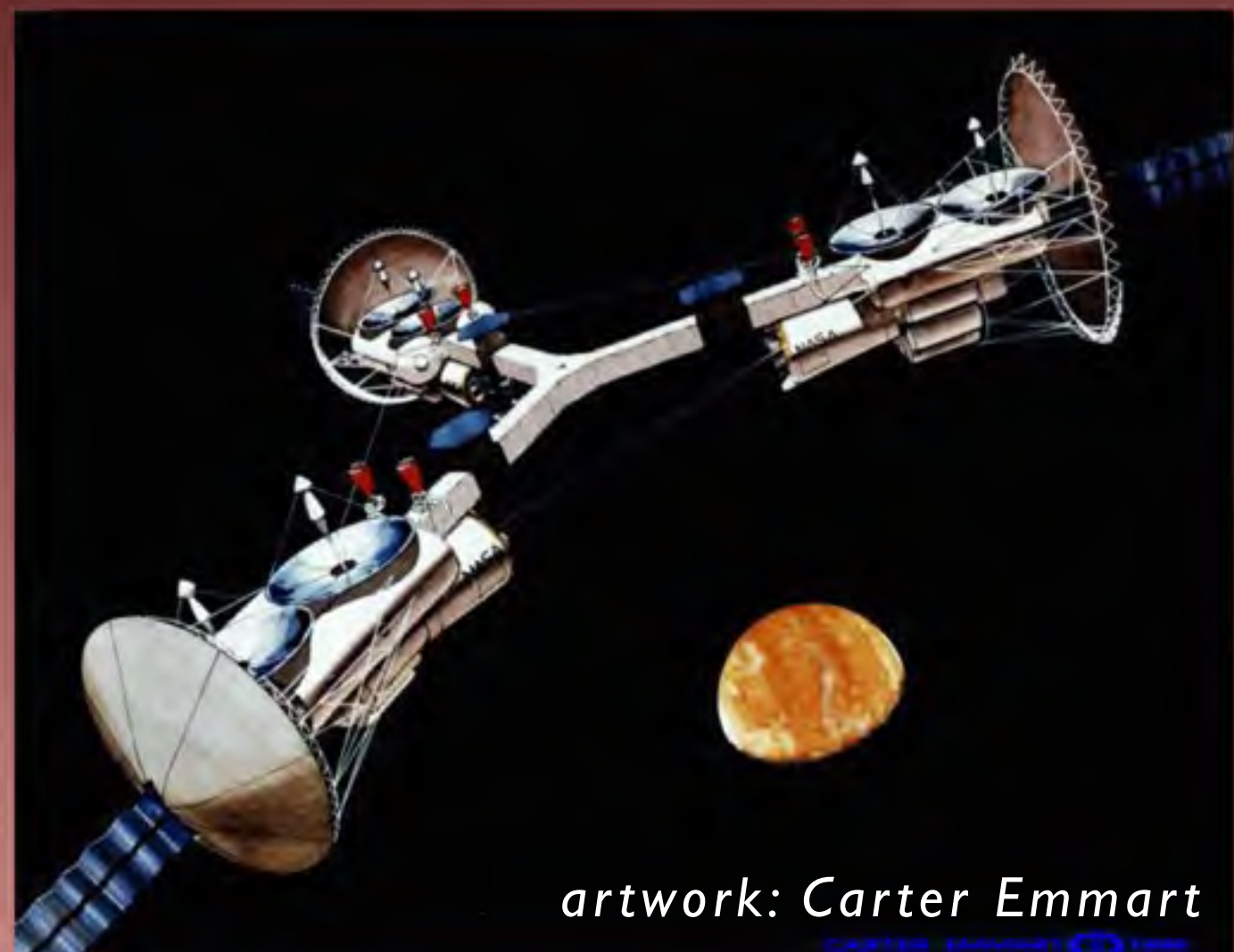
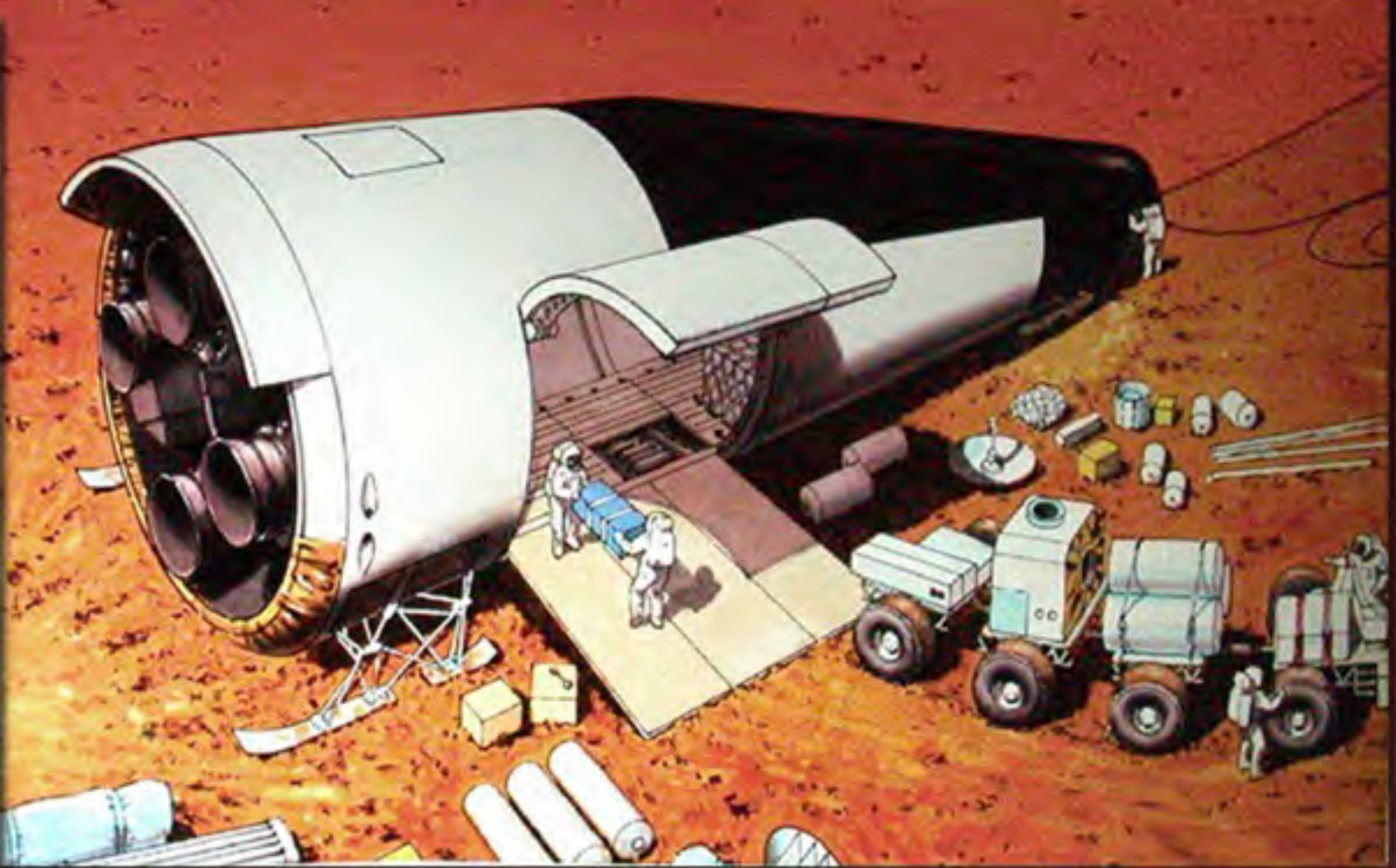
Signed at the city of Washington, D.C. in the  
United States of America  
*Robert A. Frosch* Administrator *January 7, 2017*  
Approved: NASA 17-01





**1981: The Mars Underground**





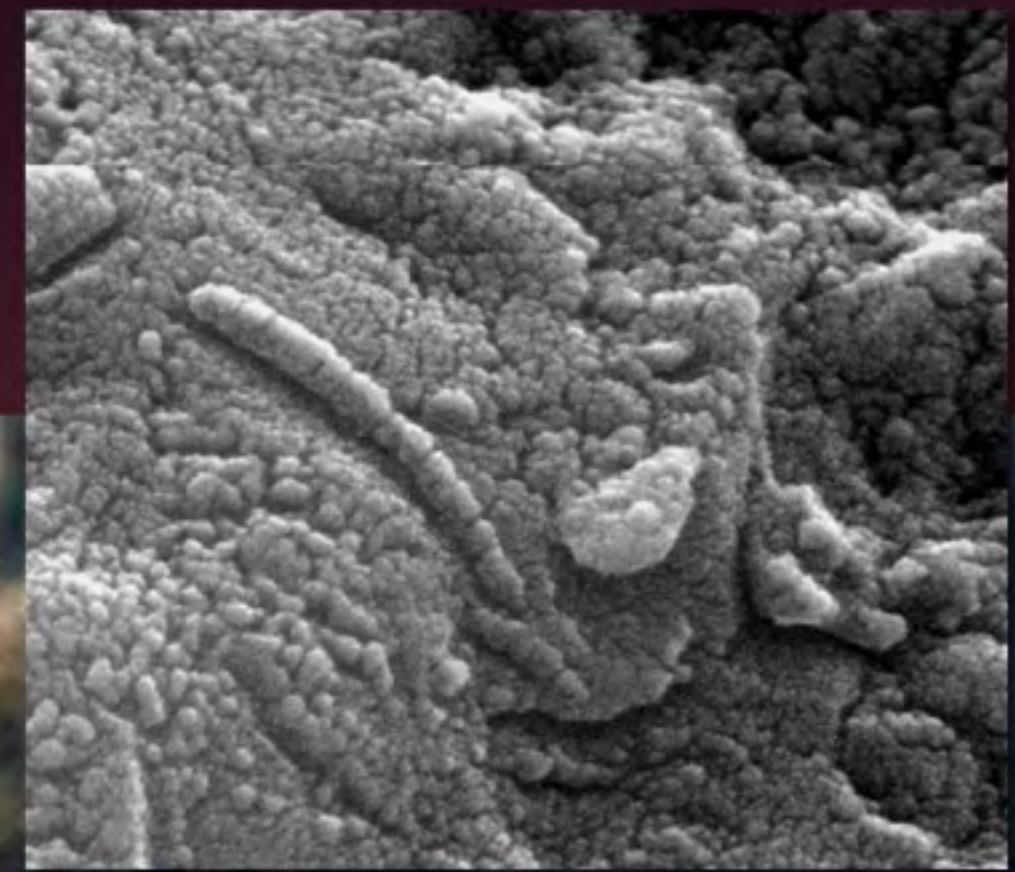
artwork: Carter Emmart



# 1996: The Science Without a Subject

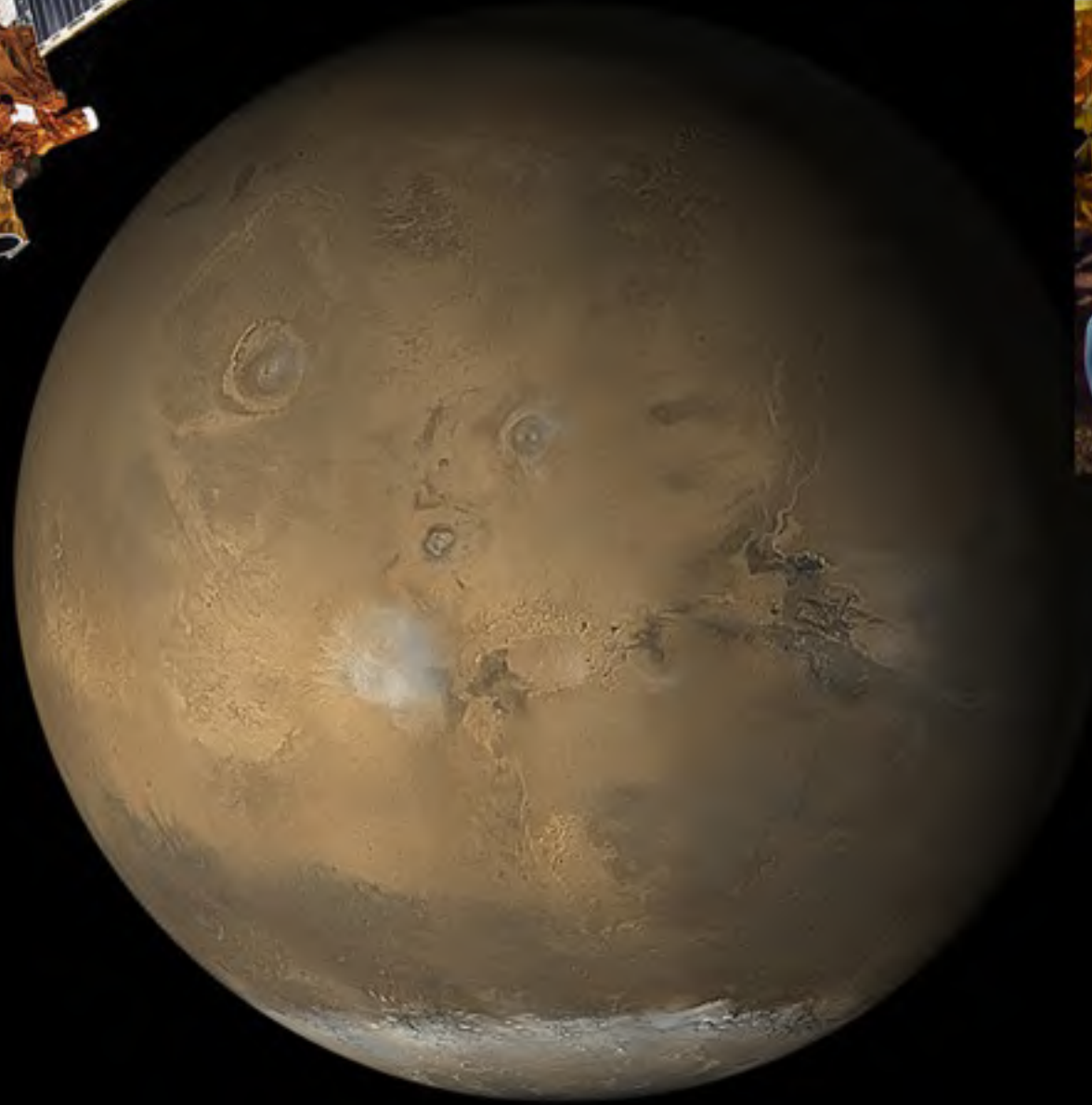






**“Extraordinary claims require extraordinary evidence.”**  
**~ Carl Sagan**

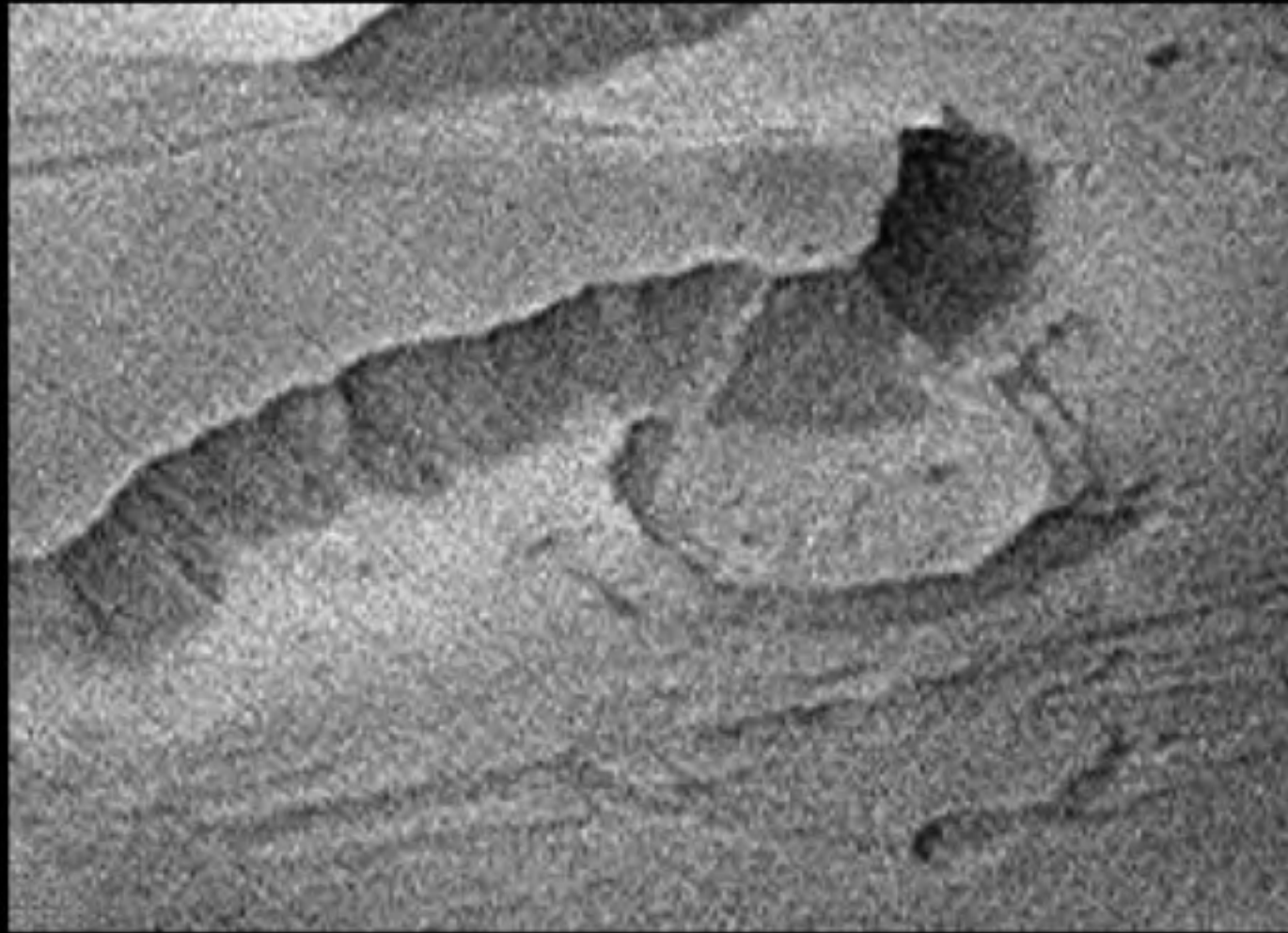




**1999: Not Your Mother's Mars**



# Clues to the Hidden Mars



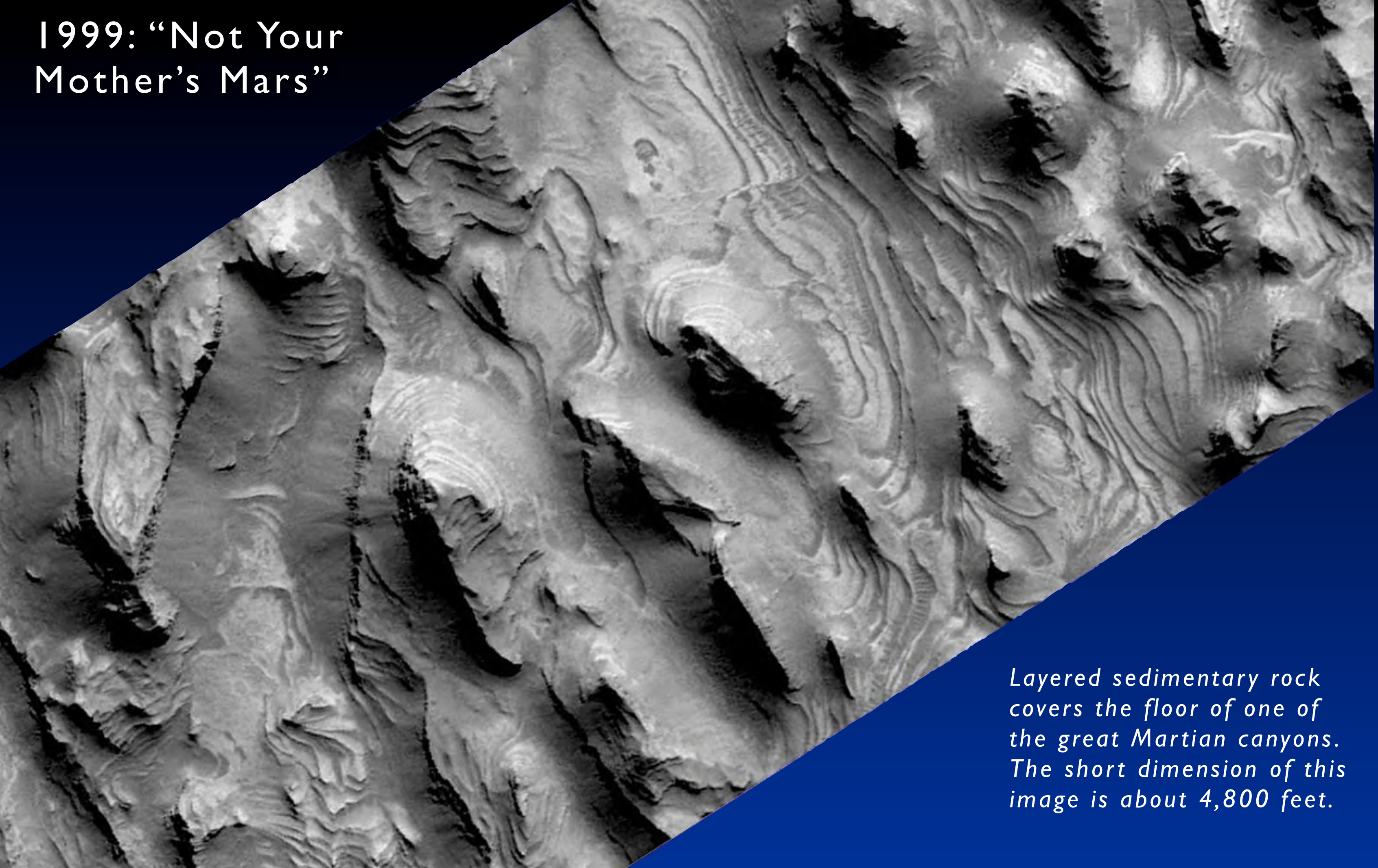
Mariner 9

Viking Orbiter



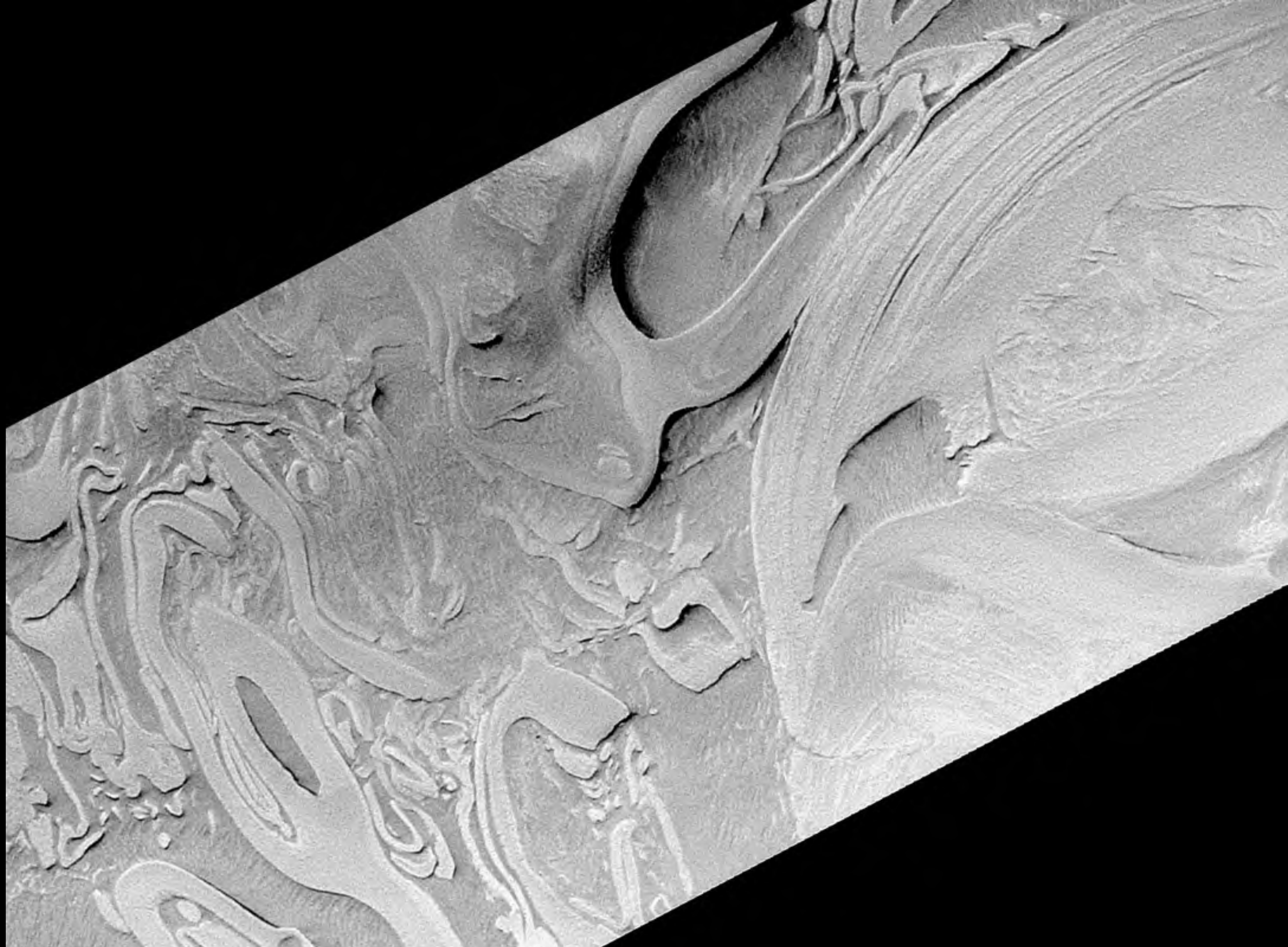


1999: "Not Your  
Mother's Mars"

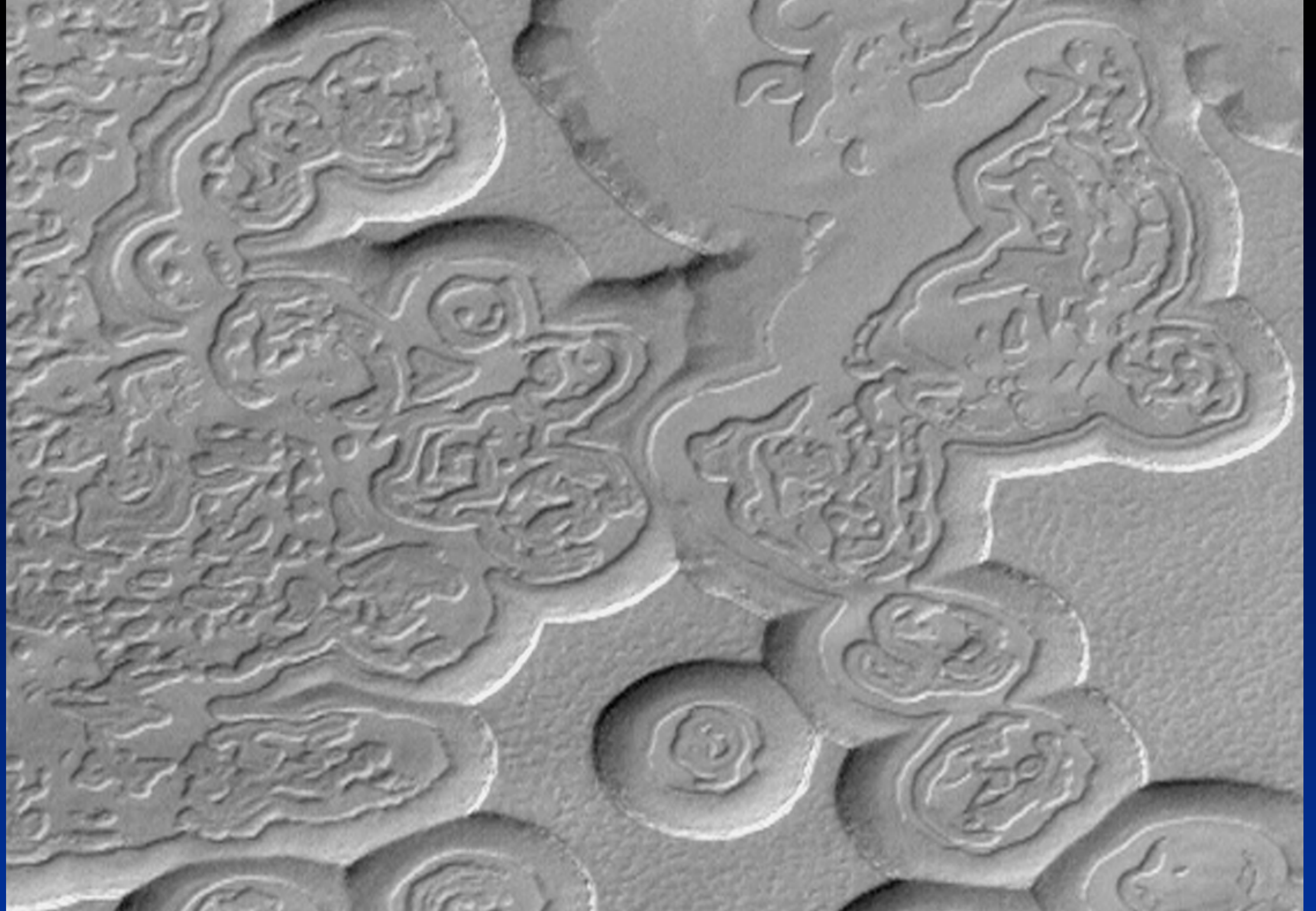


*Layered sedimentary rock covers the floor of one of the great Martian canyons. The short dimension of this image is about 4,800 feet.*



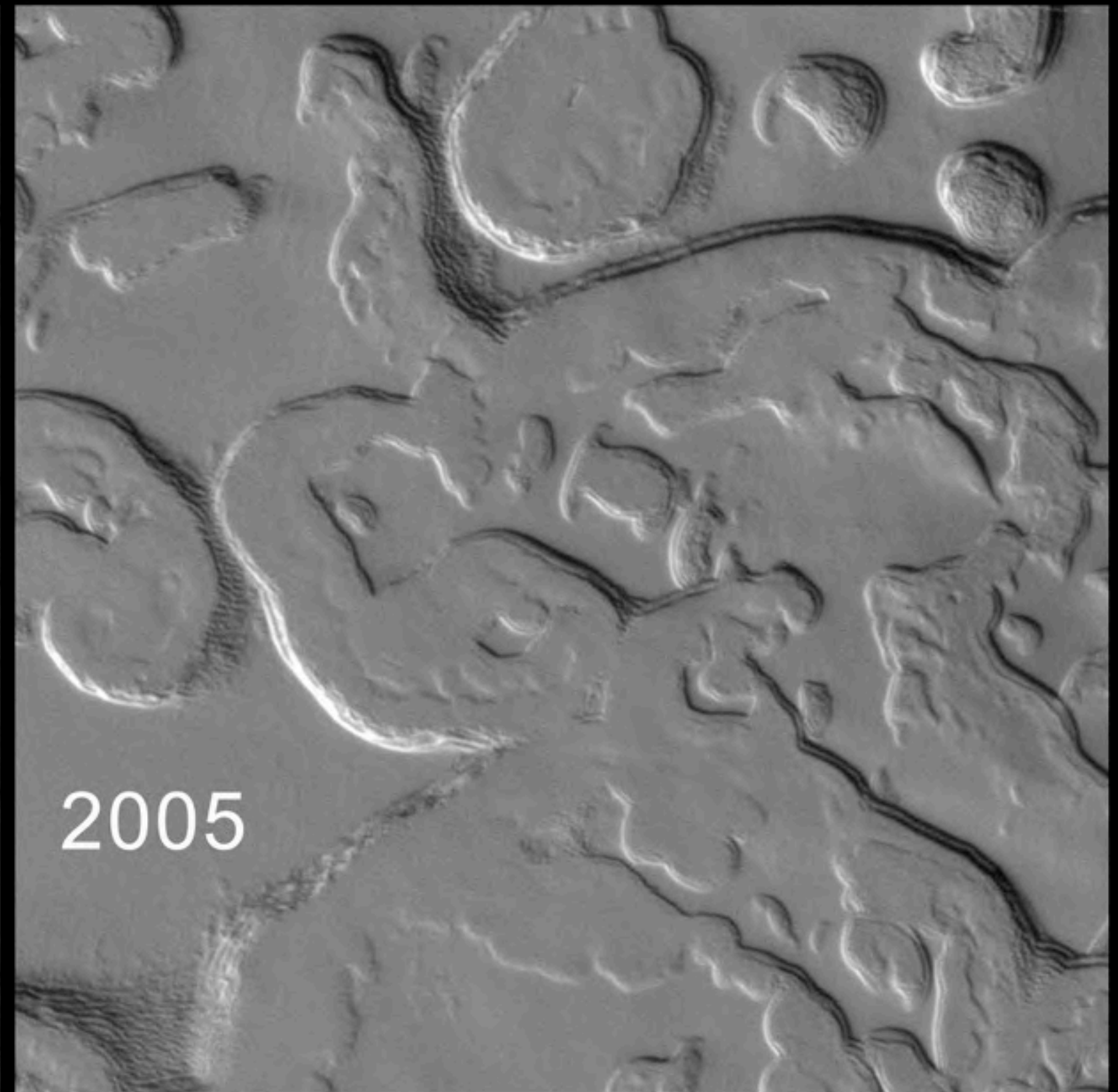
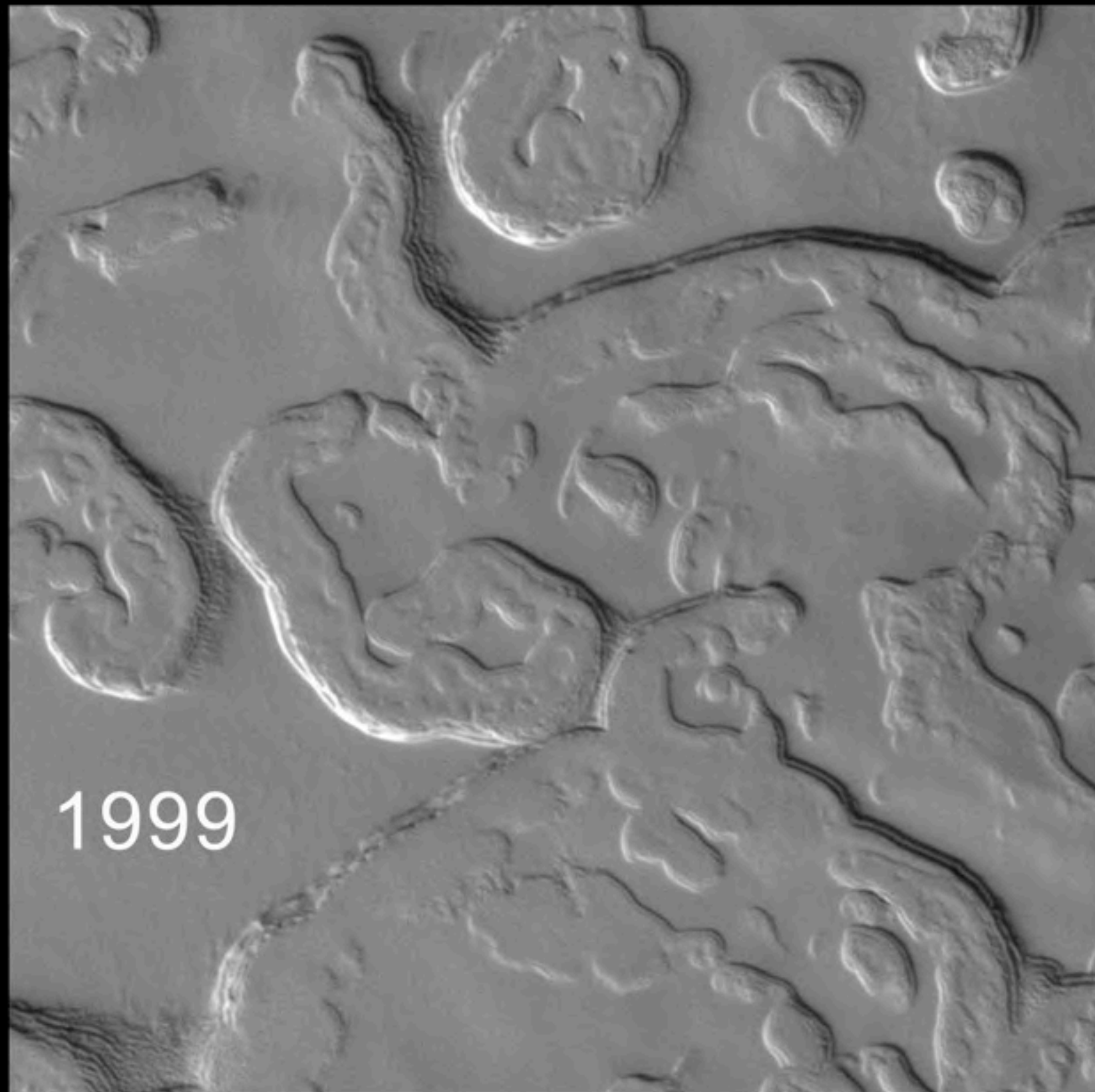




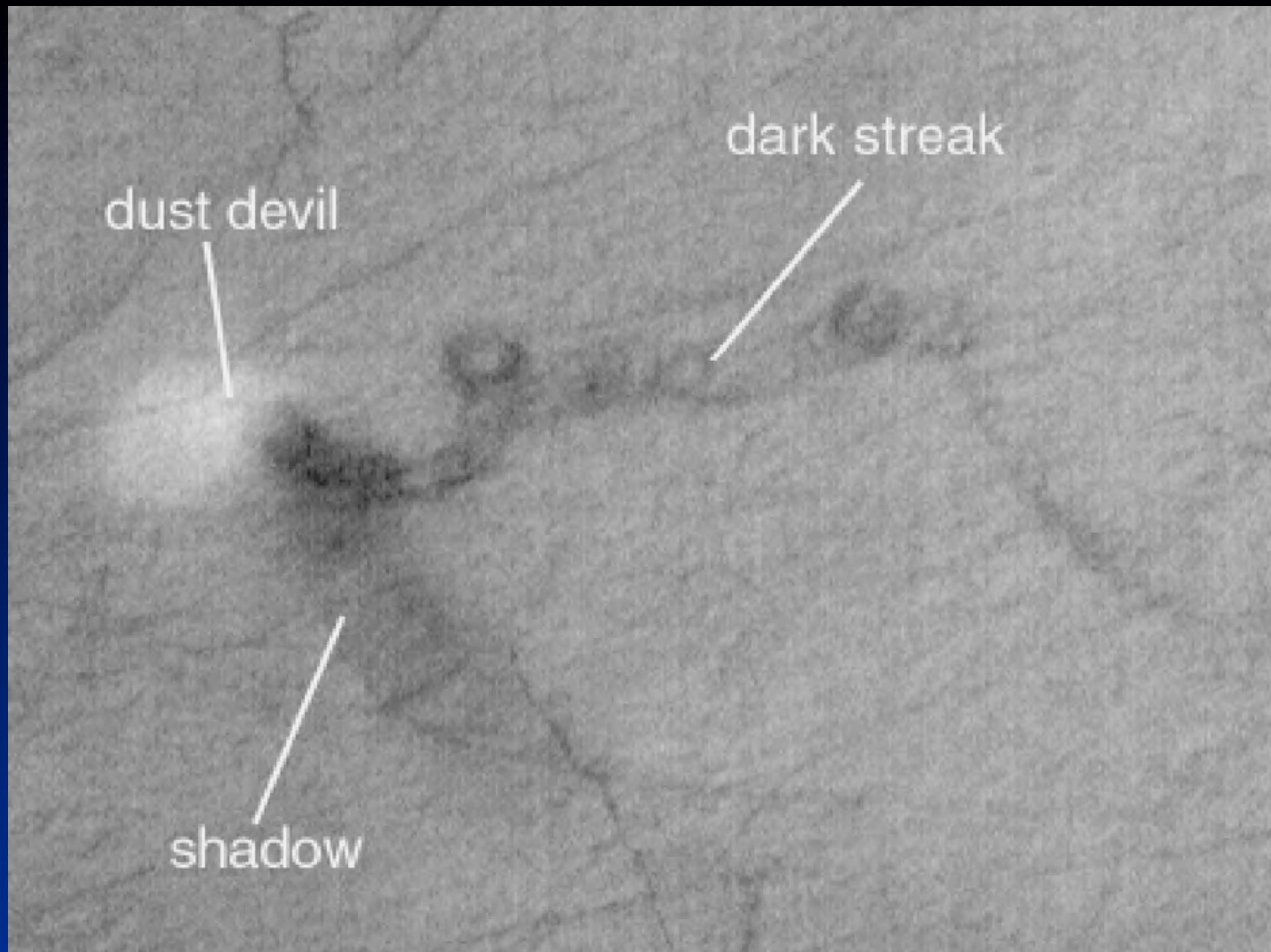




# Climate change on Mars





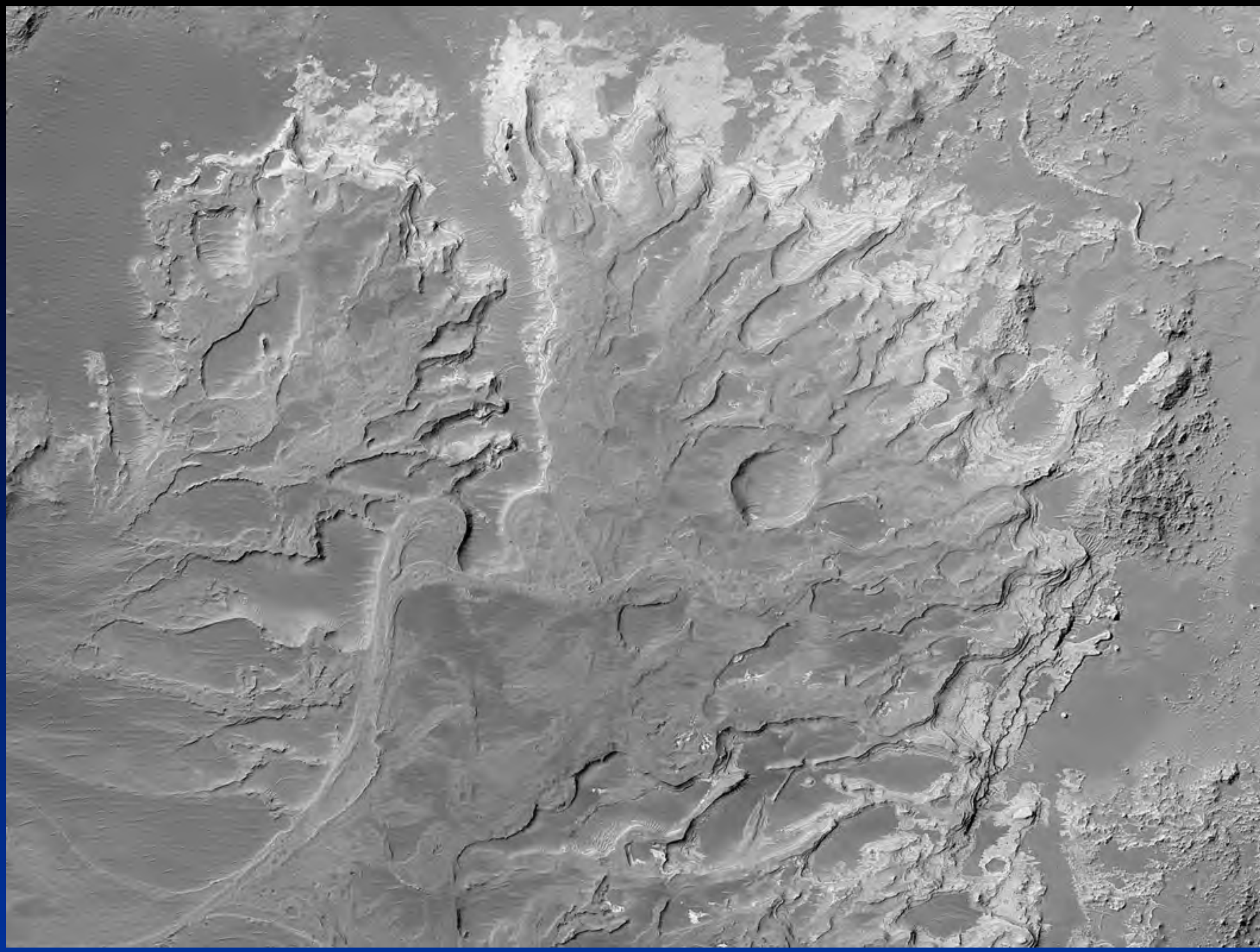


dust devil

dark streak

shadow







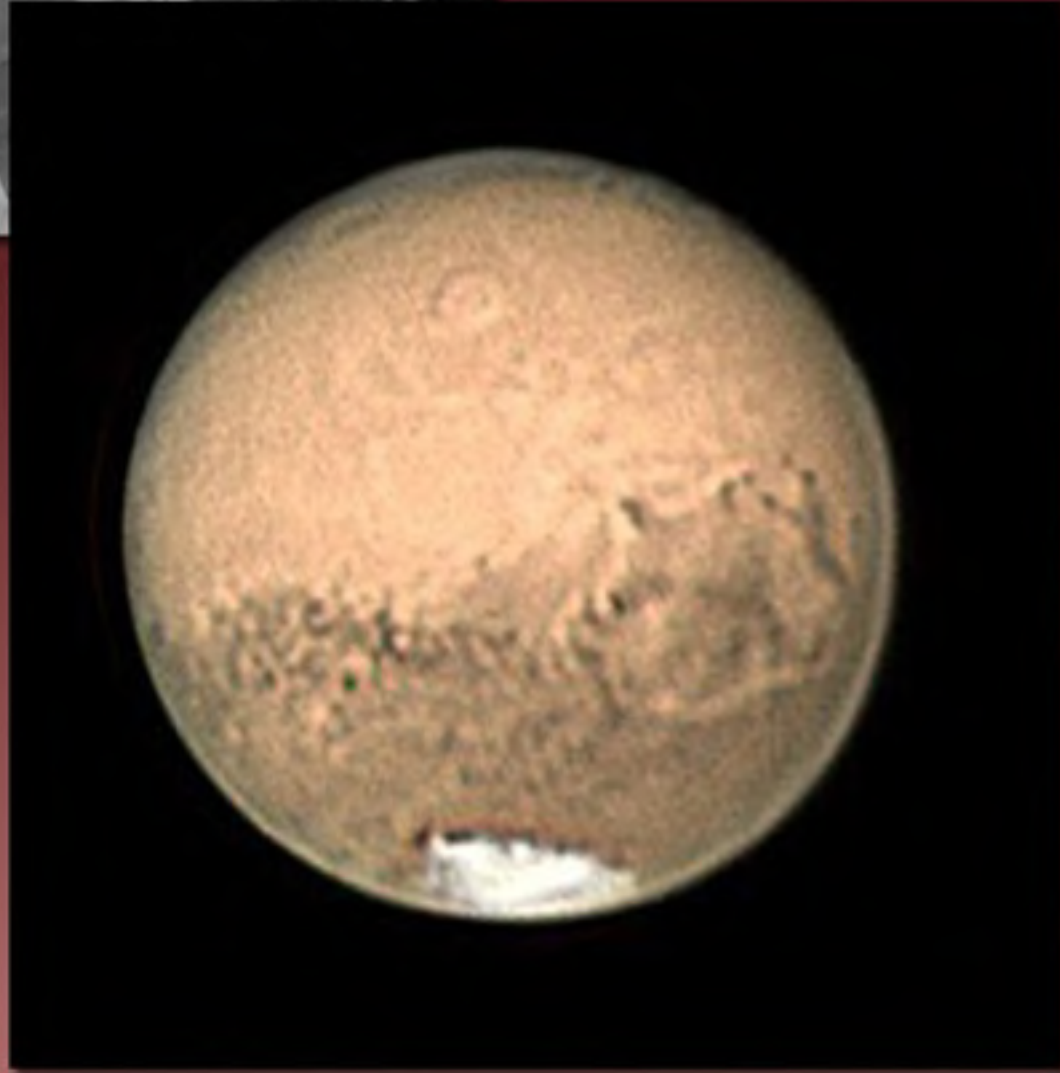
# The Curse of the Red Planet







**Mars 2003**  
**Don Parker**  
**16-inch telescope**  
**Coral Gables, FL**



**Parker**



**Hubble**





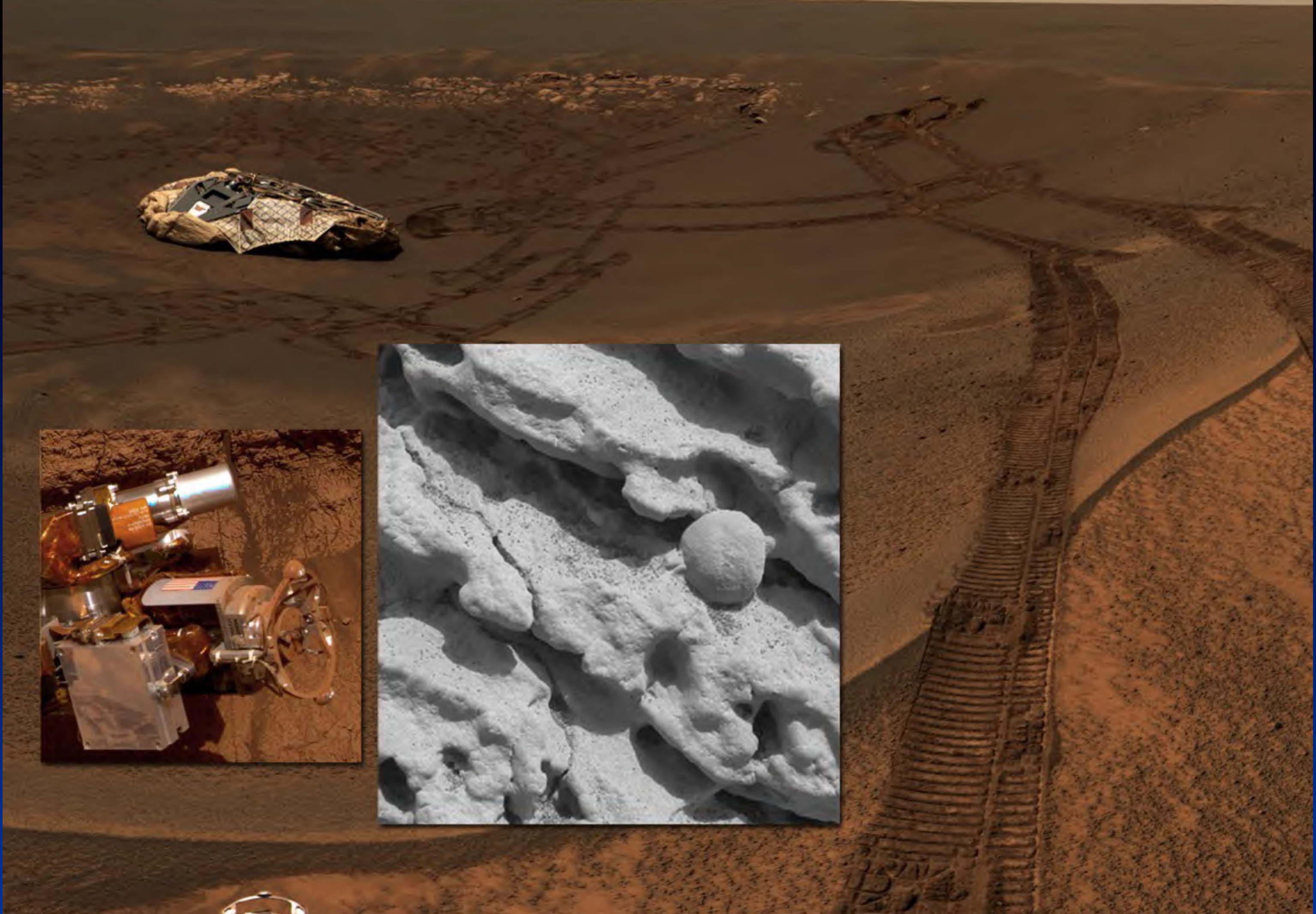
**2004: Spirit and Opportunity**



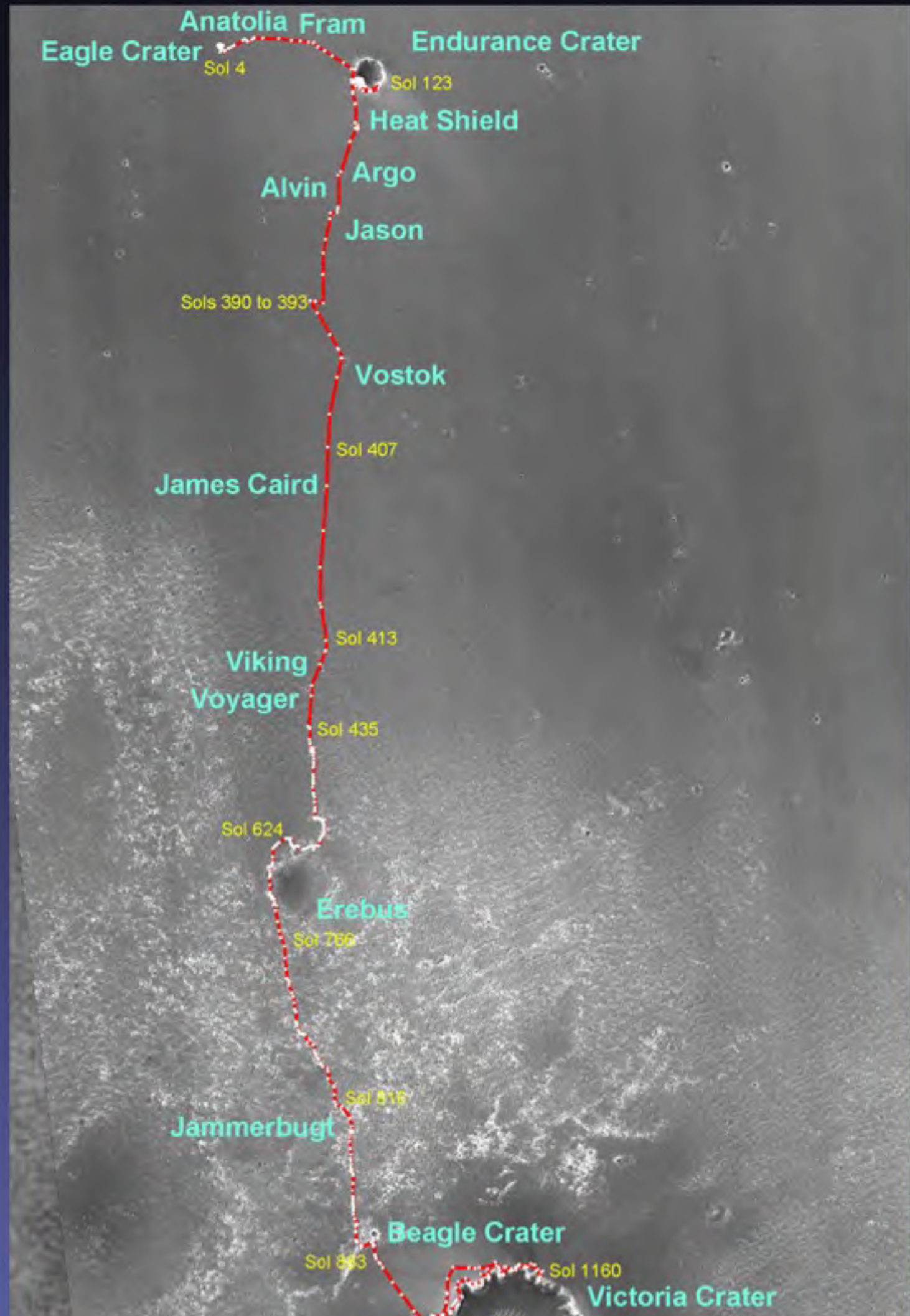
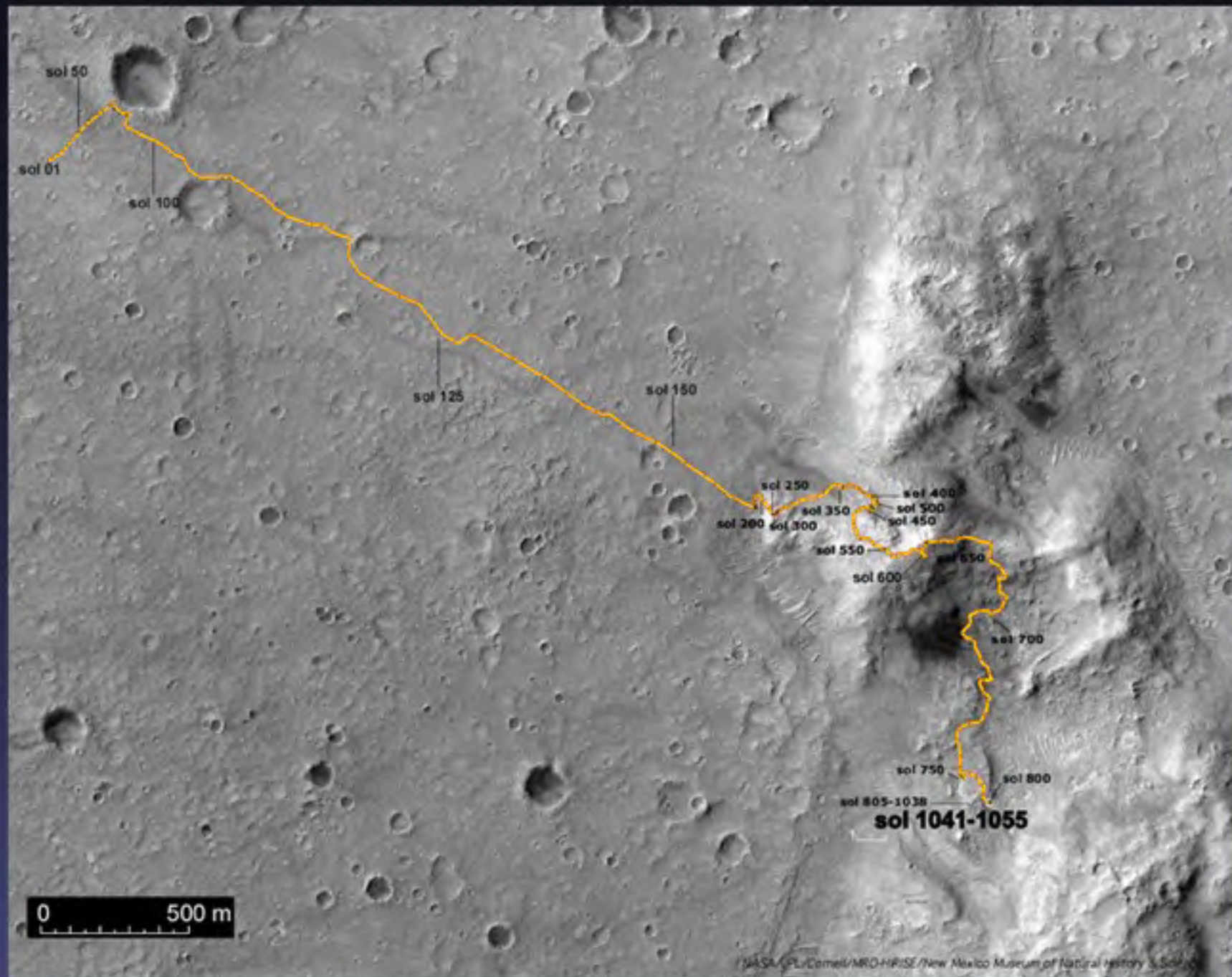


**“The whole story ... is one of heroism.”**



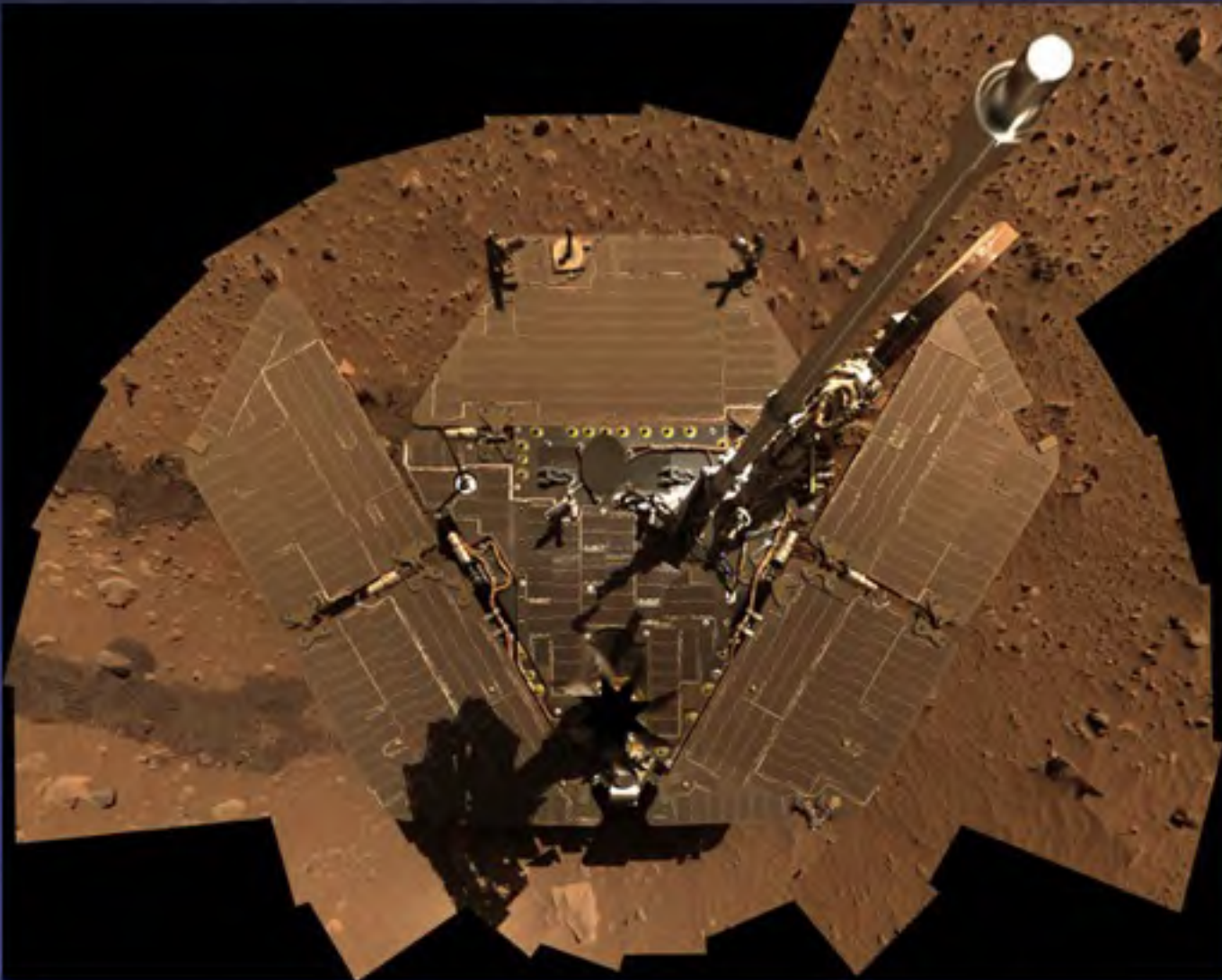
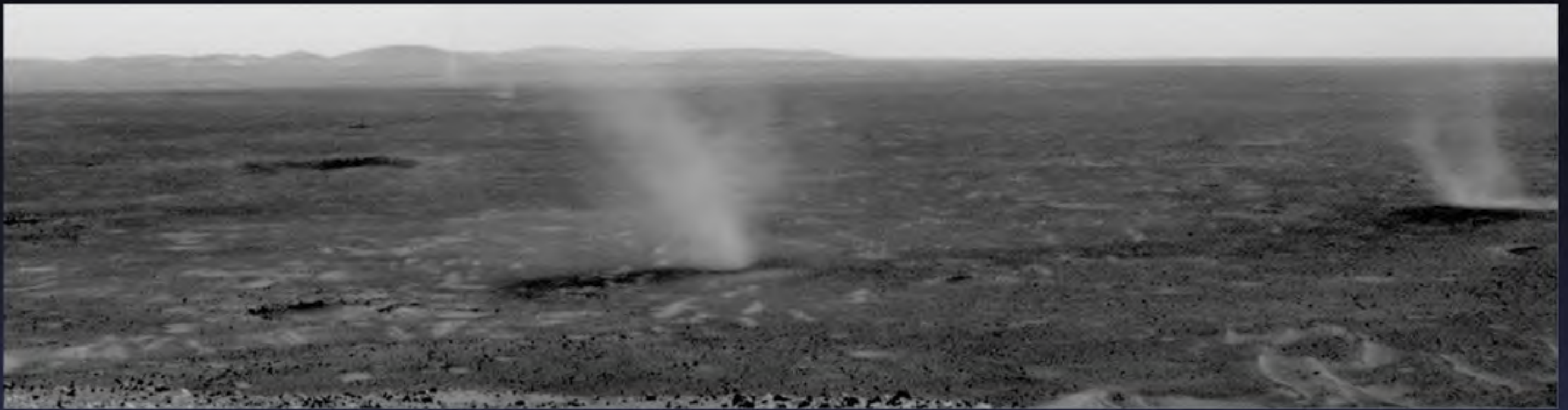






# Spirit and Opportunity: The first overland treks





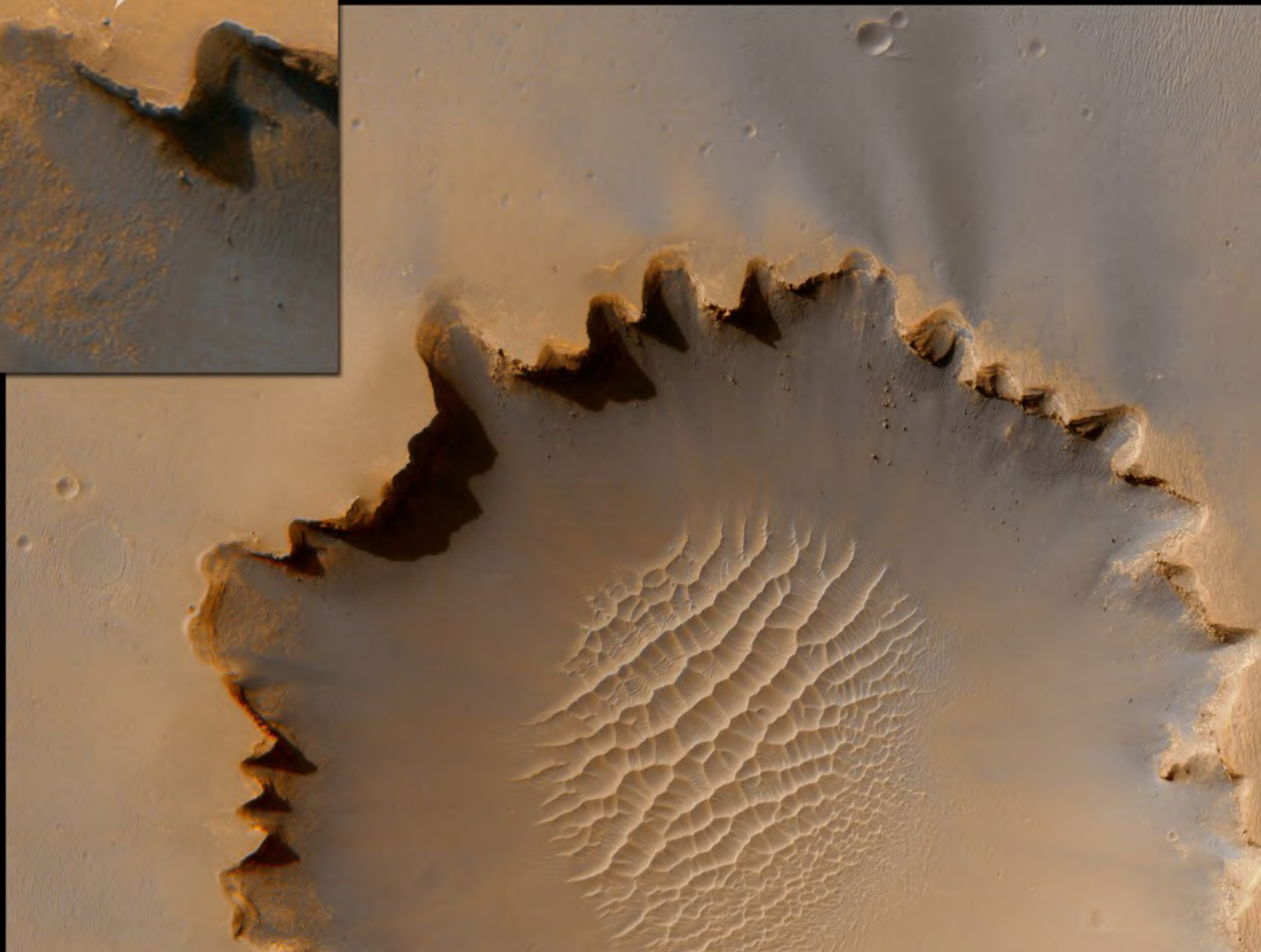
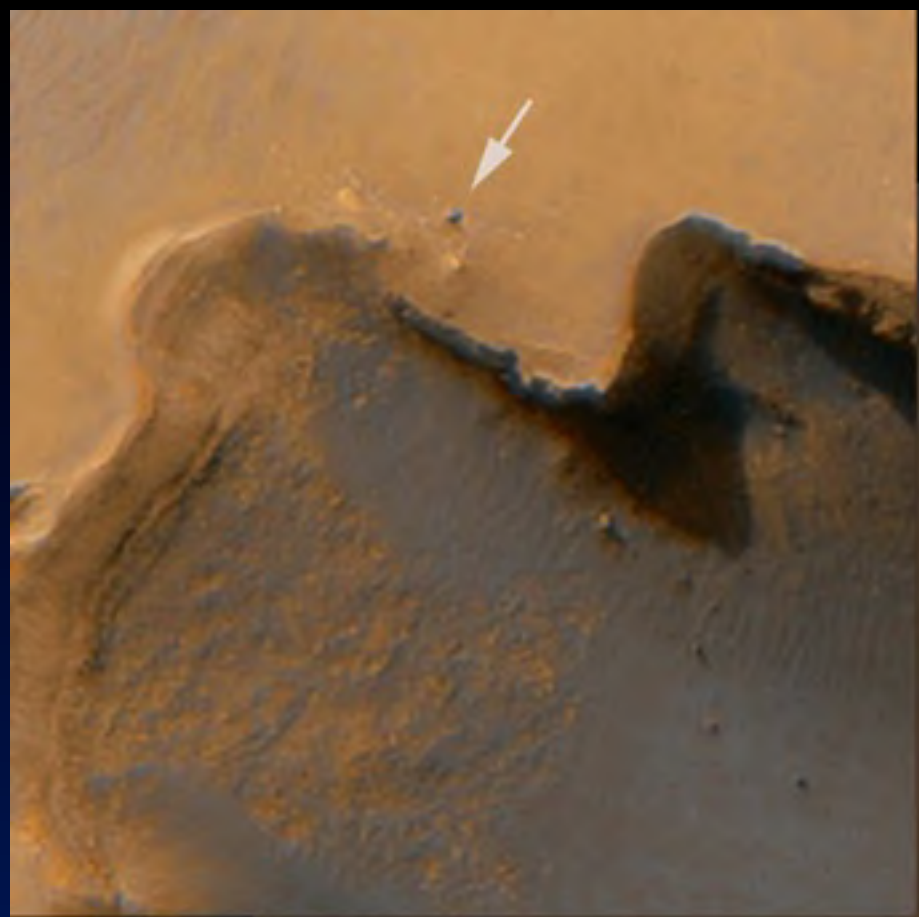
**2005: Spirit gets lucky**





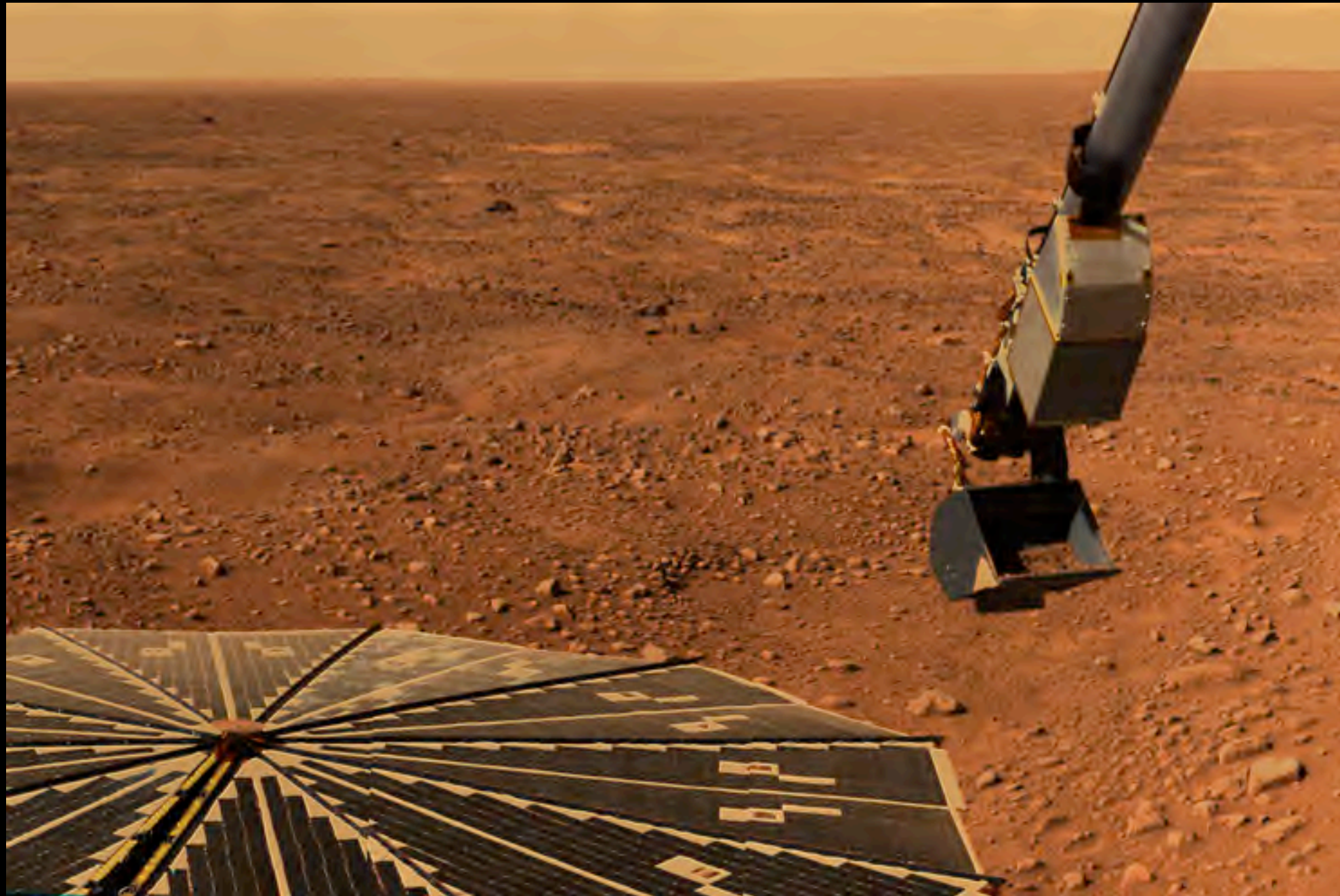
**“Sol 580 of our ninety-sol mission ...”**







# May 2008: Mars Phoenix lands in the Martian Arctic

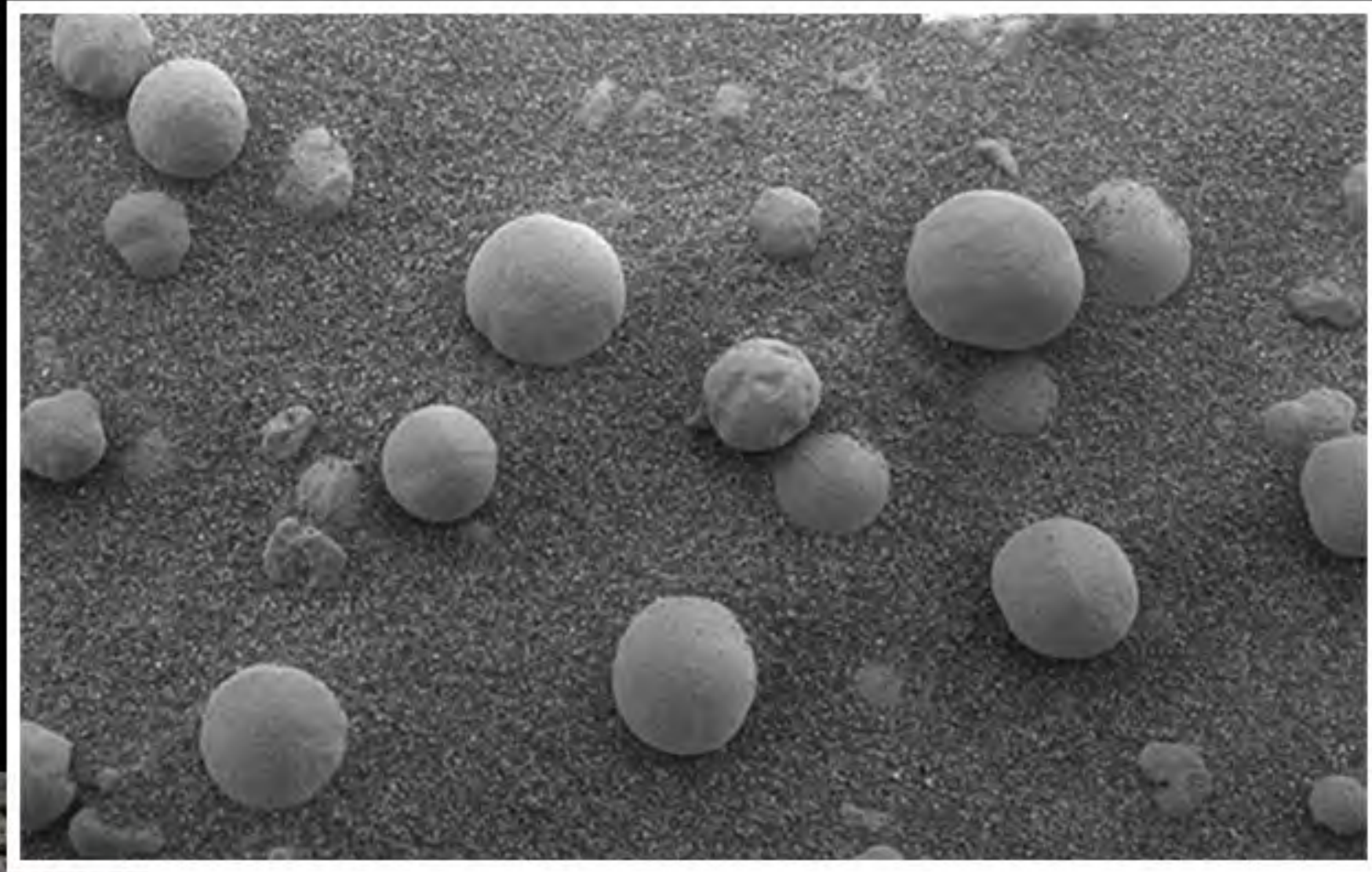


*Mars Phoenix scooped into the icy soil and discovered reactive compounds called perchlorates.*



# Opportunity concretions

Robots vs. Machines?



Apollo 17 orange soil

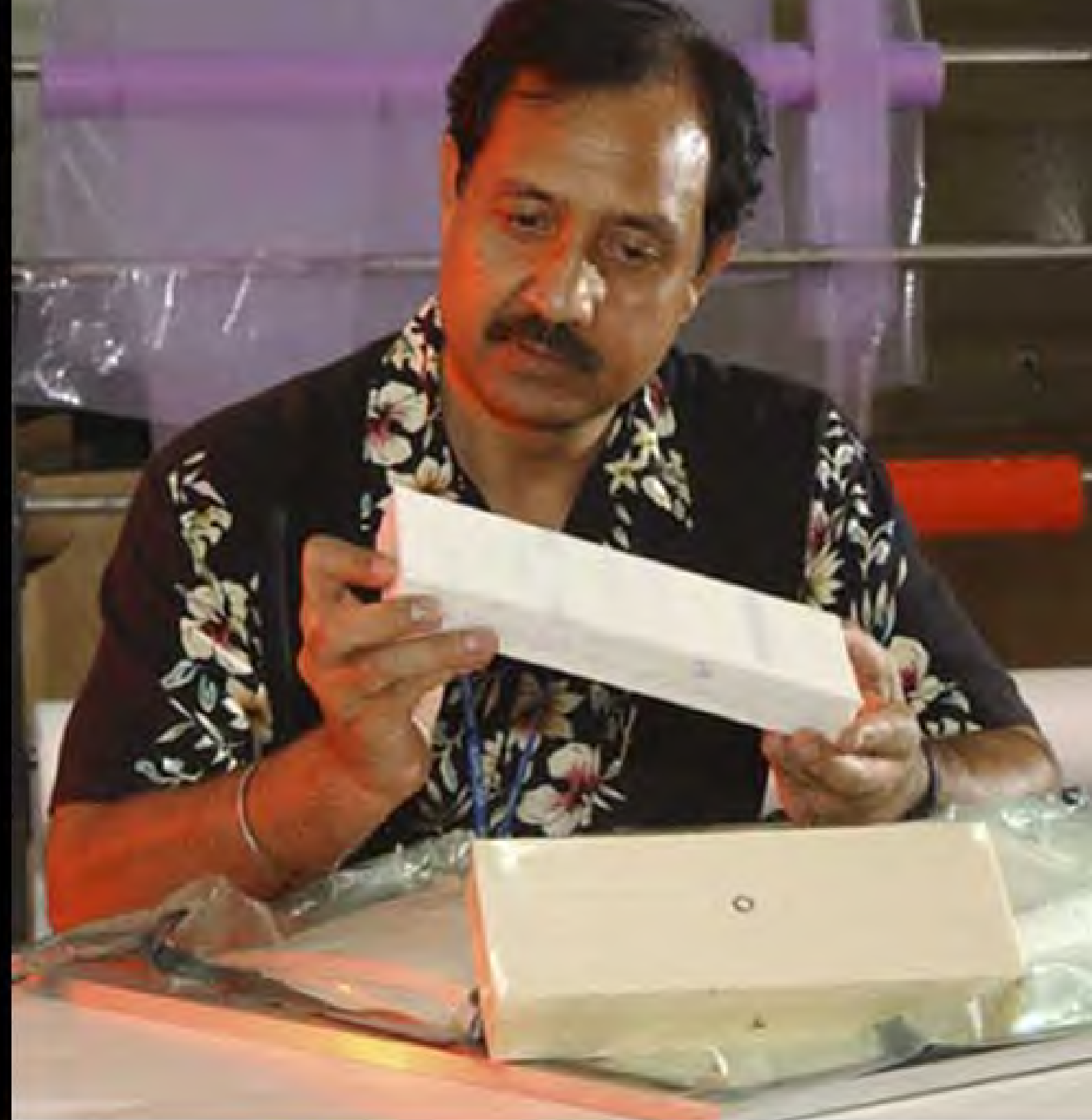
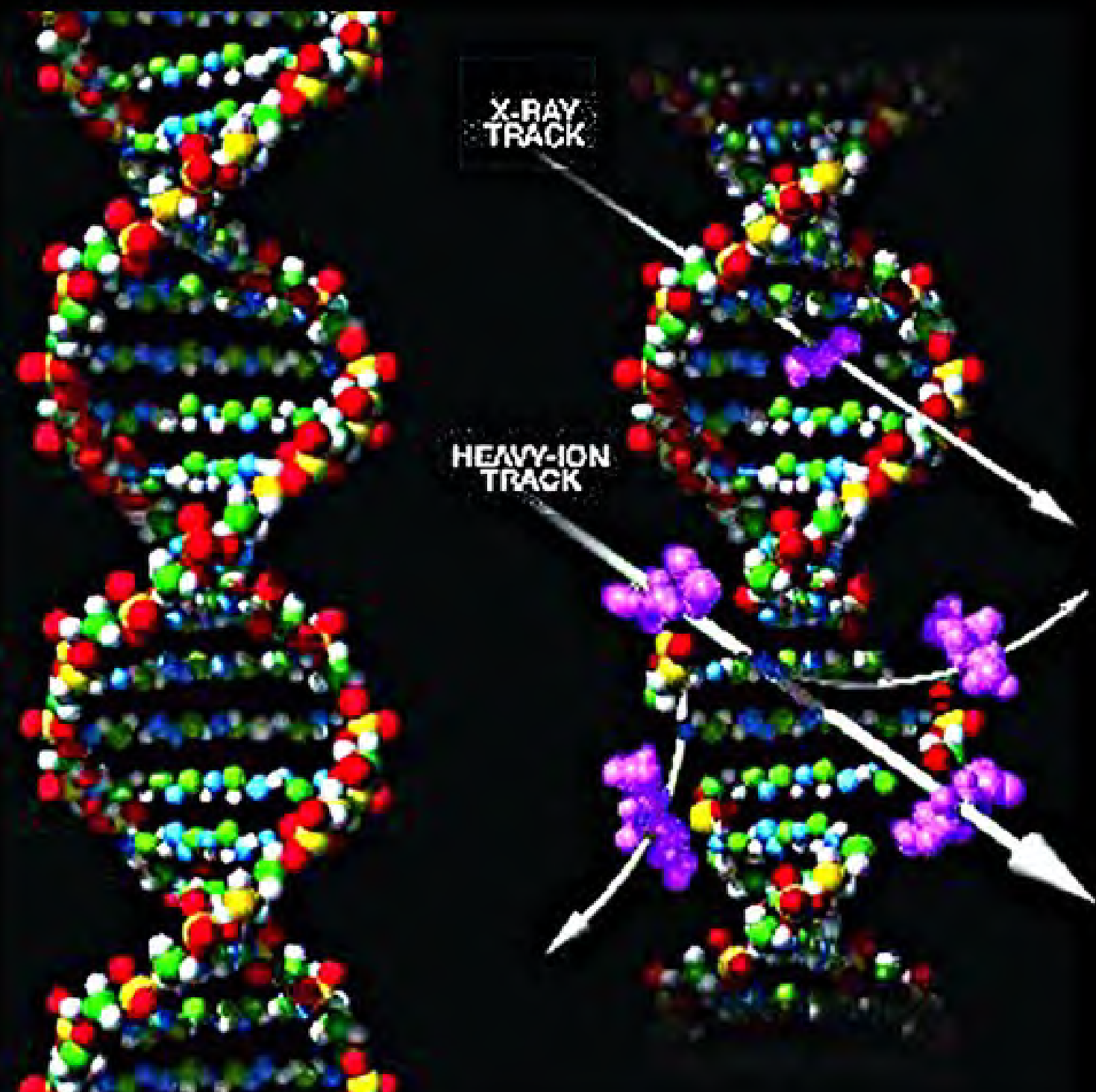




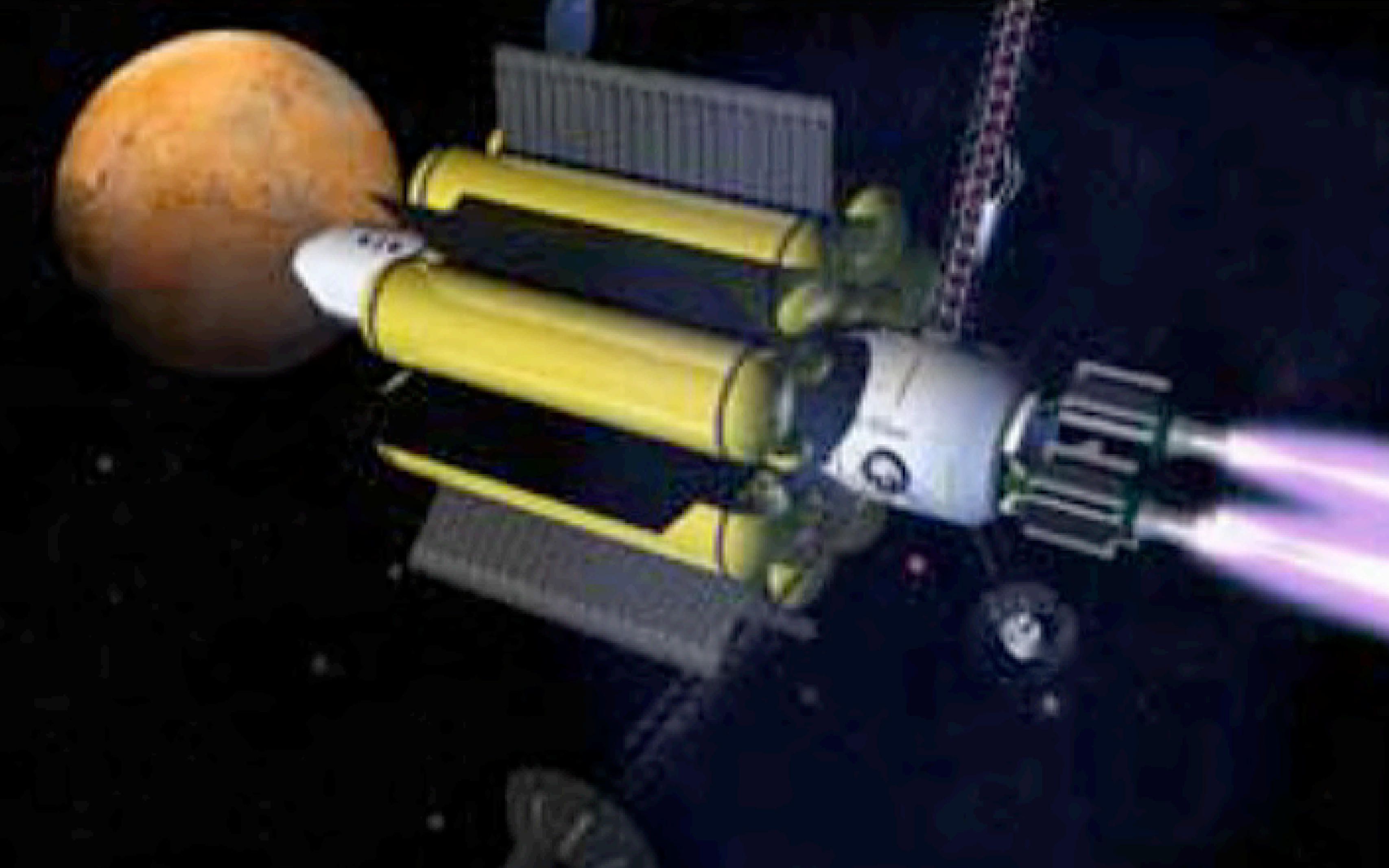






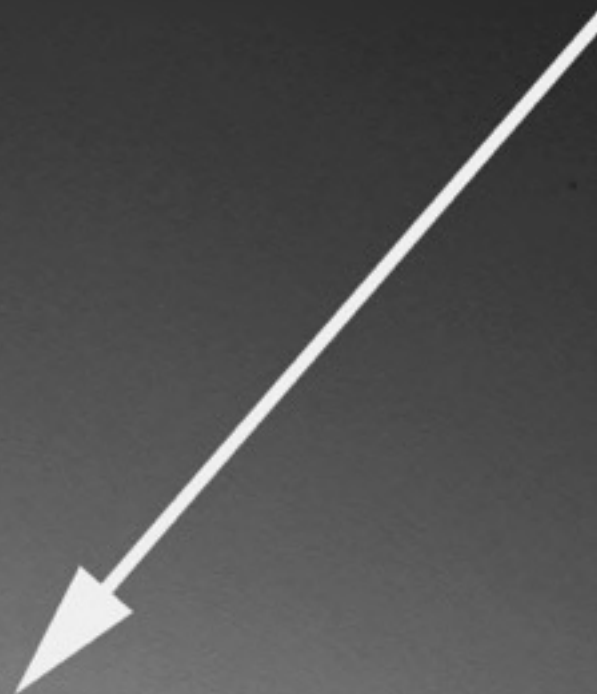
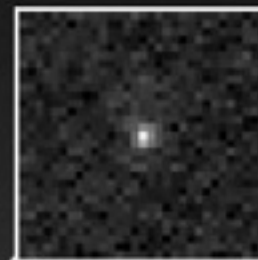








You are here



**Tomorrowland**





**“Too soon from the cave, too far from the stars.”  
~ Ray Bradbury**