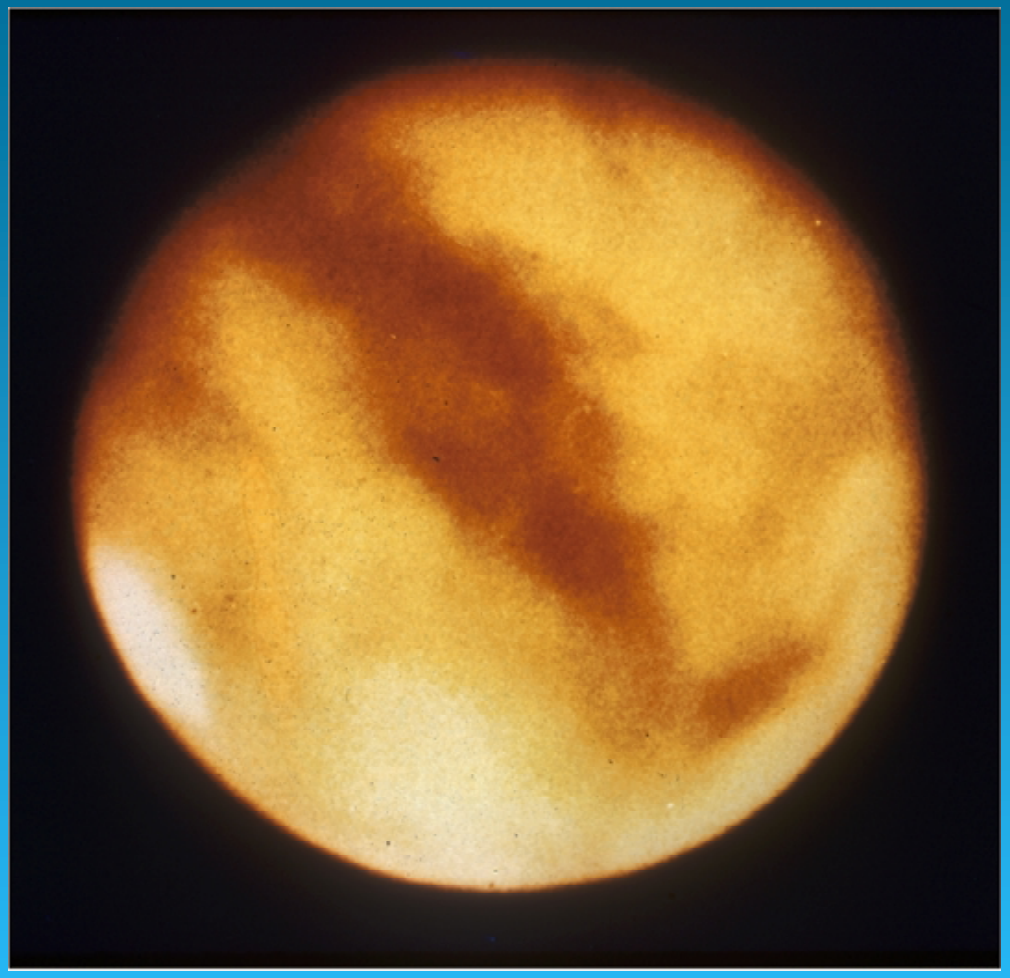
MARS - THE ASTROBIOLOGY CONNECTION

Ronald Greeley
Arizona State University



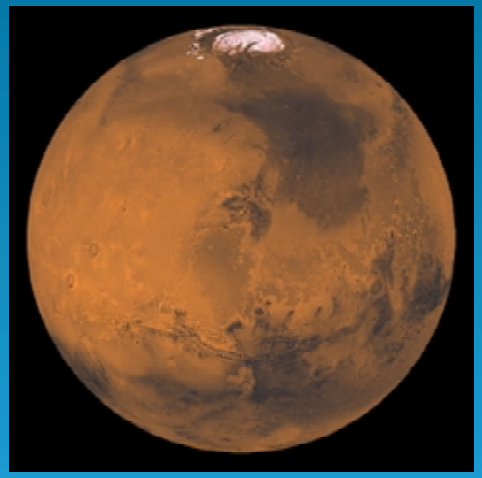
Exploration:

- Past
- Present
- Future

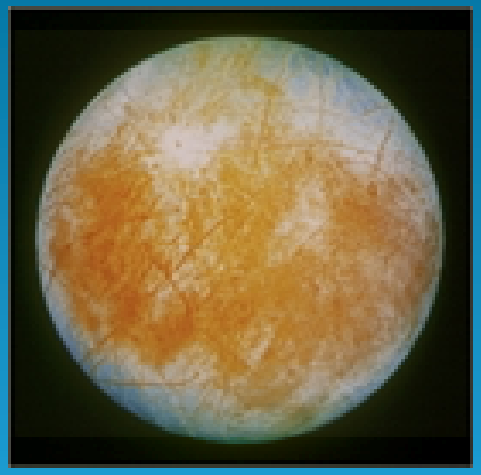
WHERE DO WE SEARCH FOR LIFE IN THE SOLAR SYSTEM?

The essential ingredients for life

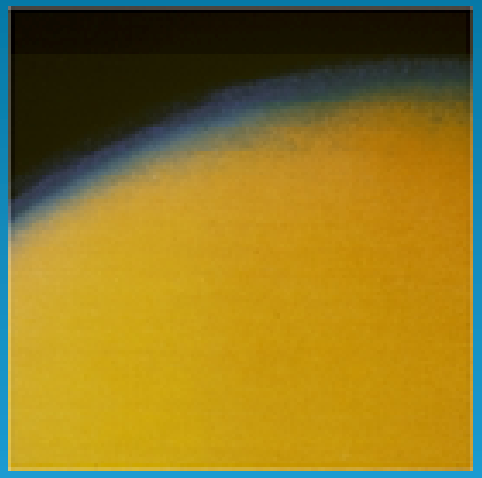
- Water
- Organics
- Energy



Mars



Europa



Titan

The approach is to look for environments where these ingredients come together

WHY MARS?

- Most “Earthlike” of the planets
- Life “ingredients” present
- Easier to get to

SPACECRAFT TO MARS

Scoreboard

Visitors - 13, Mars Home Team - 20

Launch	Successes	Failures
1960		unnamed*
1962		unnamed*
		Mars 1*
		unnamed*
1964	Mariner 4	Mariner 3
		Zond 2*
1965		Zond 3*
1969	Mariner 6	unnamed*
	Mariner 7	unnamed*
1971	Mariner 9	Mariner 8
		Kosmos 419*
		Mars 2*
		Mars 3*
1973	Mars 5*	Mars 4*
	Mars 6*	Mars 7*
1975	Viking 1	
	Viking 2	
1988	Phobos 1*	Phobos 2*
1992		Mars Observer
1996	Mars Global Surveyor	Mars '96*
	Mars Pathfinder	
1998	Nozomi	Mars Climate Orbiter
1999		Mars Polar Lander
2001	Odyssey	

* Soviet Union / Russia

All others US except Japan's Nozomi

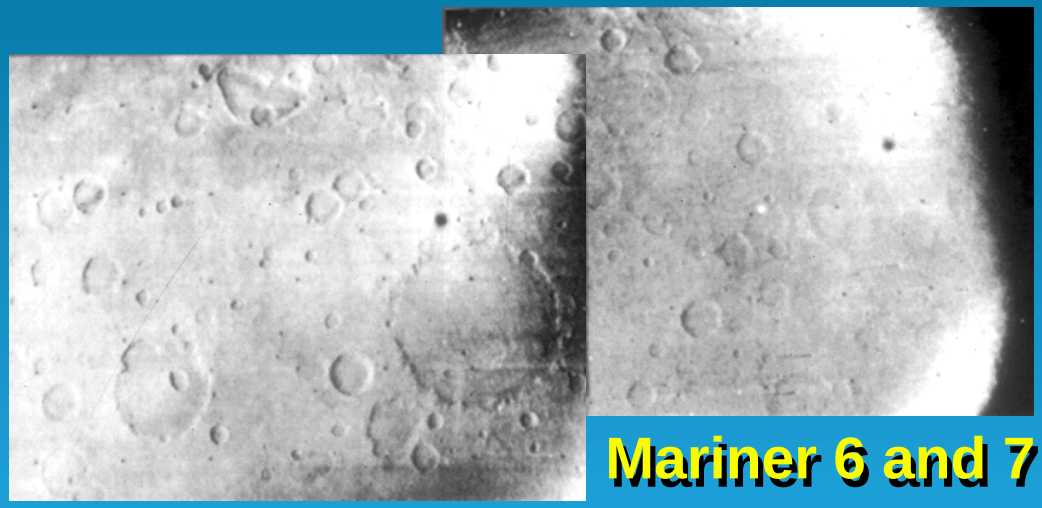
MESSAGE!

SPACE ENDEAVOURS ARE INHERENTLY RISKY, HIGHLY VISIBLE, AND PERCIEVED AS HIGH COST:

<u>THEY BETTER WORK!</u>

EARLY EXPLORATION OF MARS

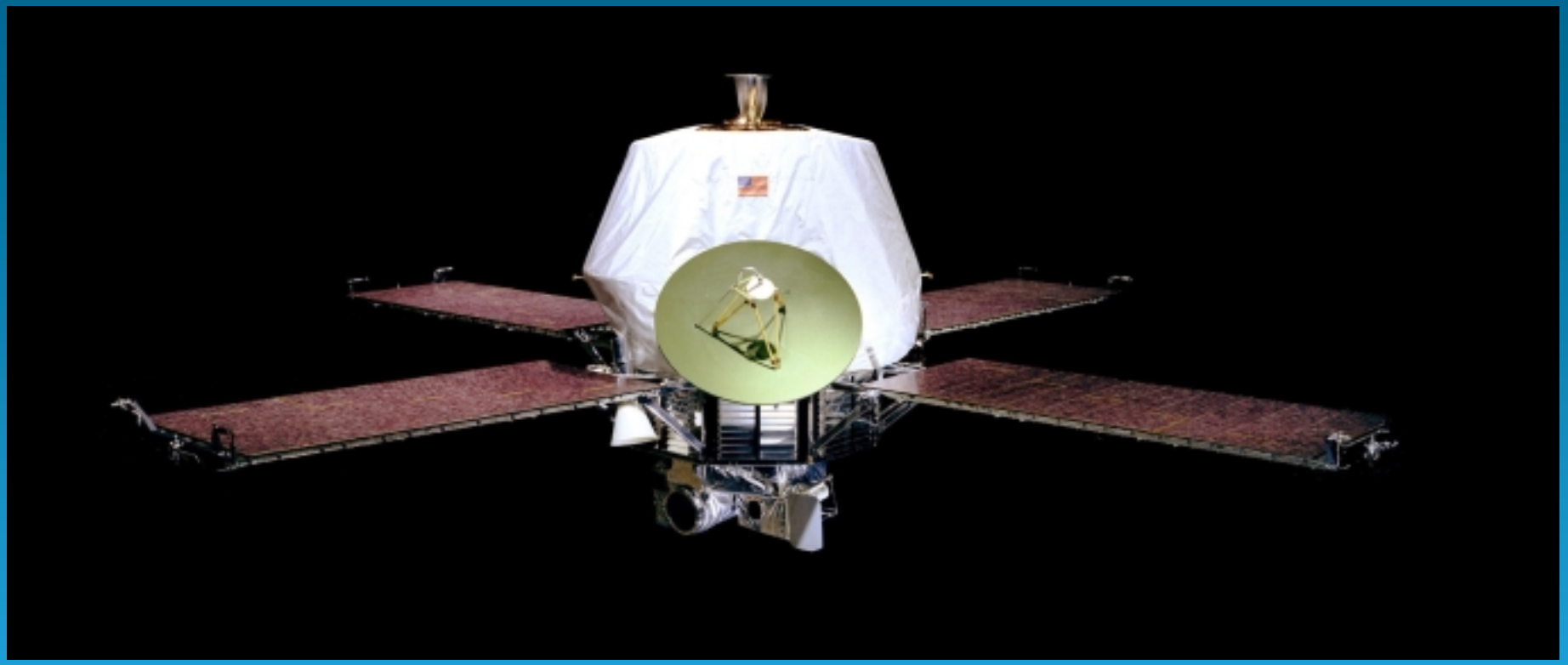
Mariner 4



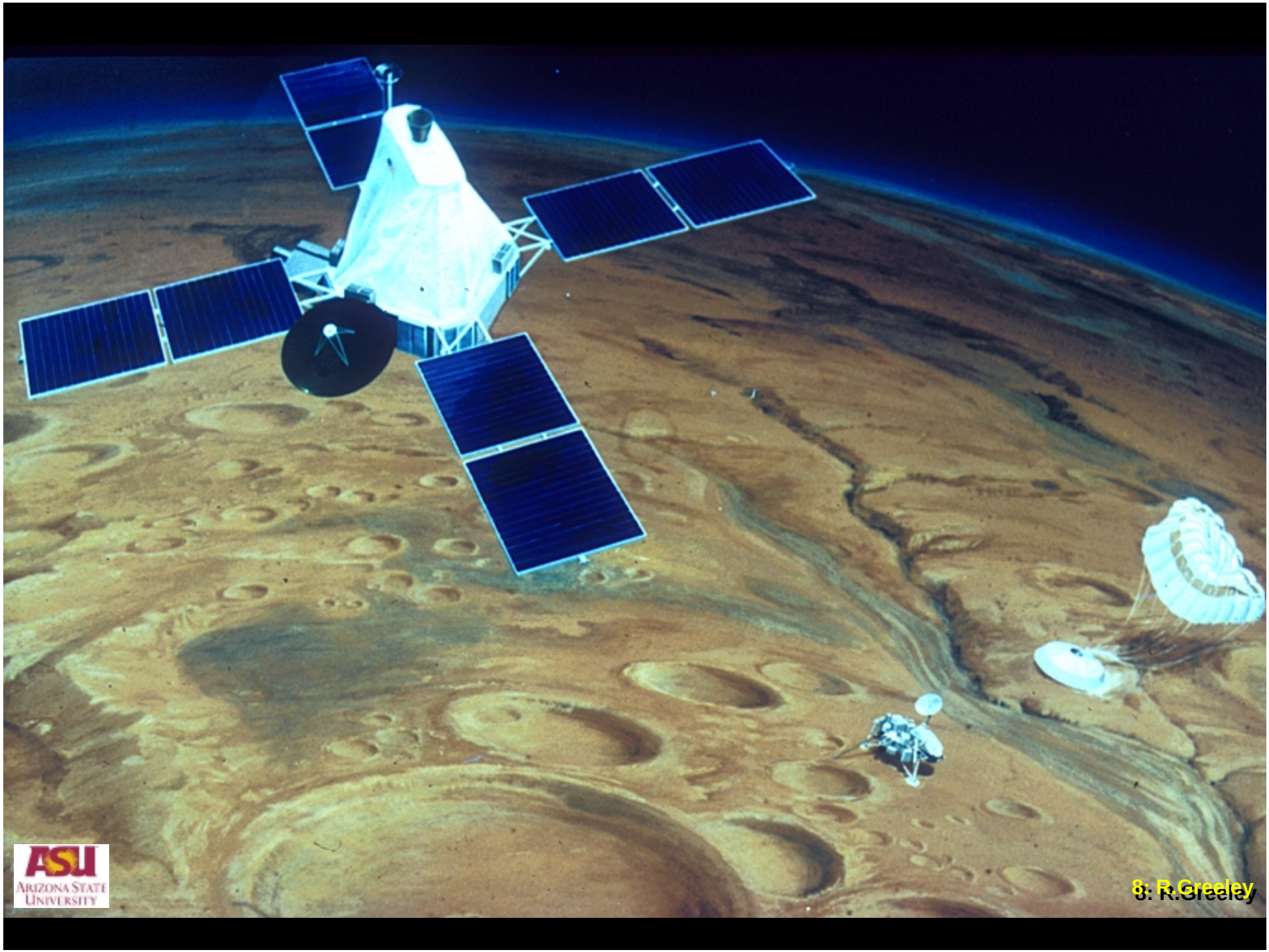
Mariner 6 and 7

…..like Earth's Moon ! ?

MARINER 9 (1971)



- First successful orbiter
- Revealed geological complexity of Mars
  - Volcanoes
  - Sand dunes
  - Landslides
  - Ancient river beds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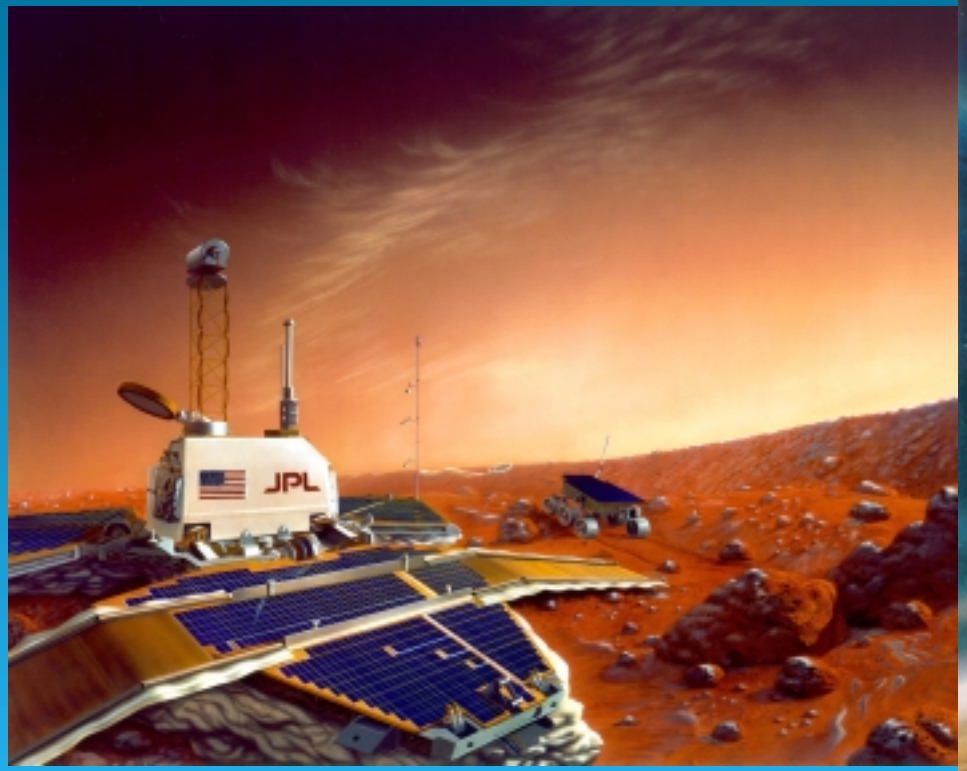
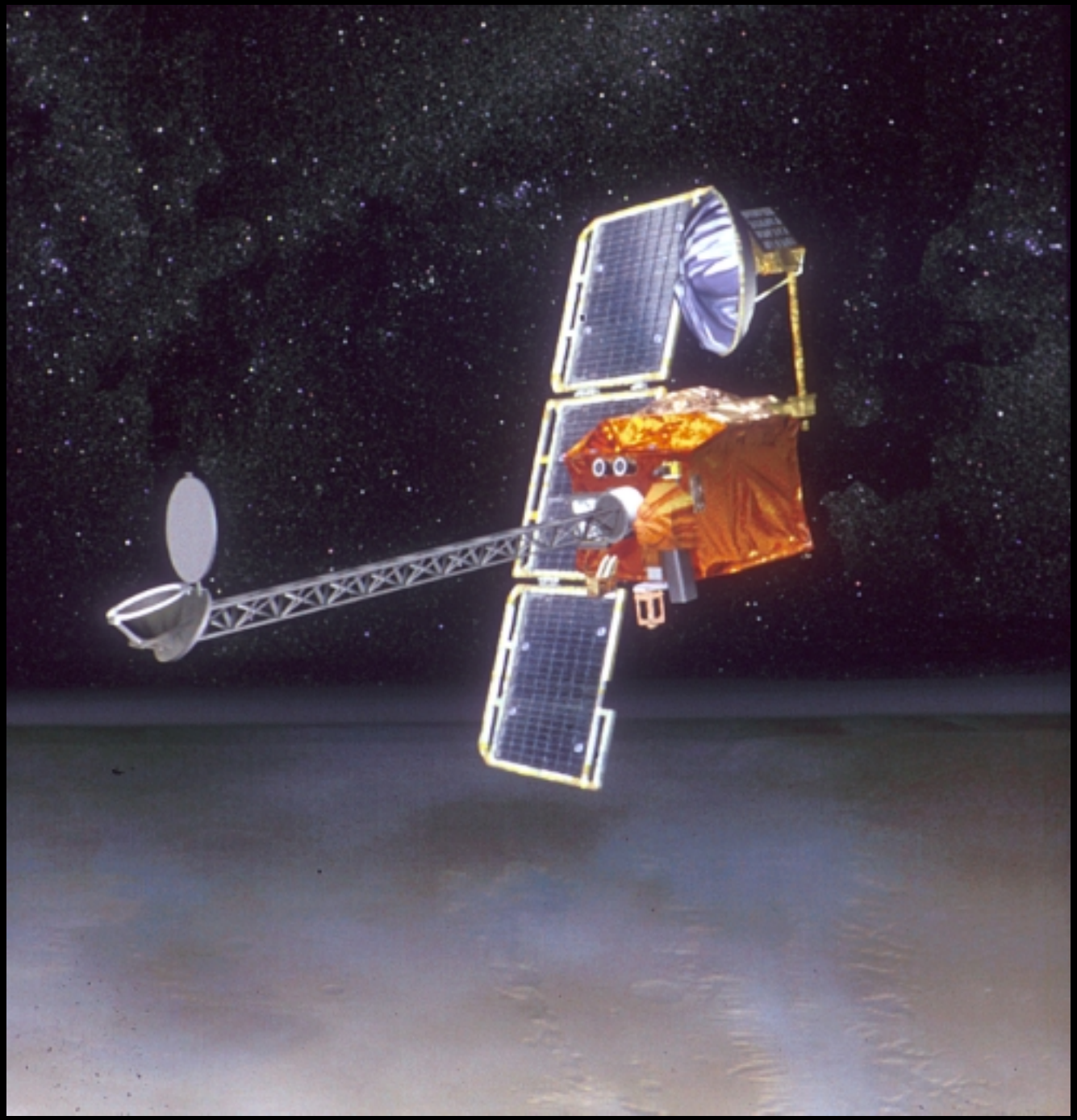
8: R.Greeley

MESSAGE FROM VIKING EXOBIOLOGY

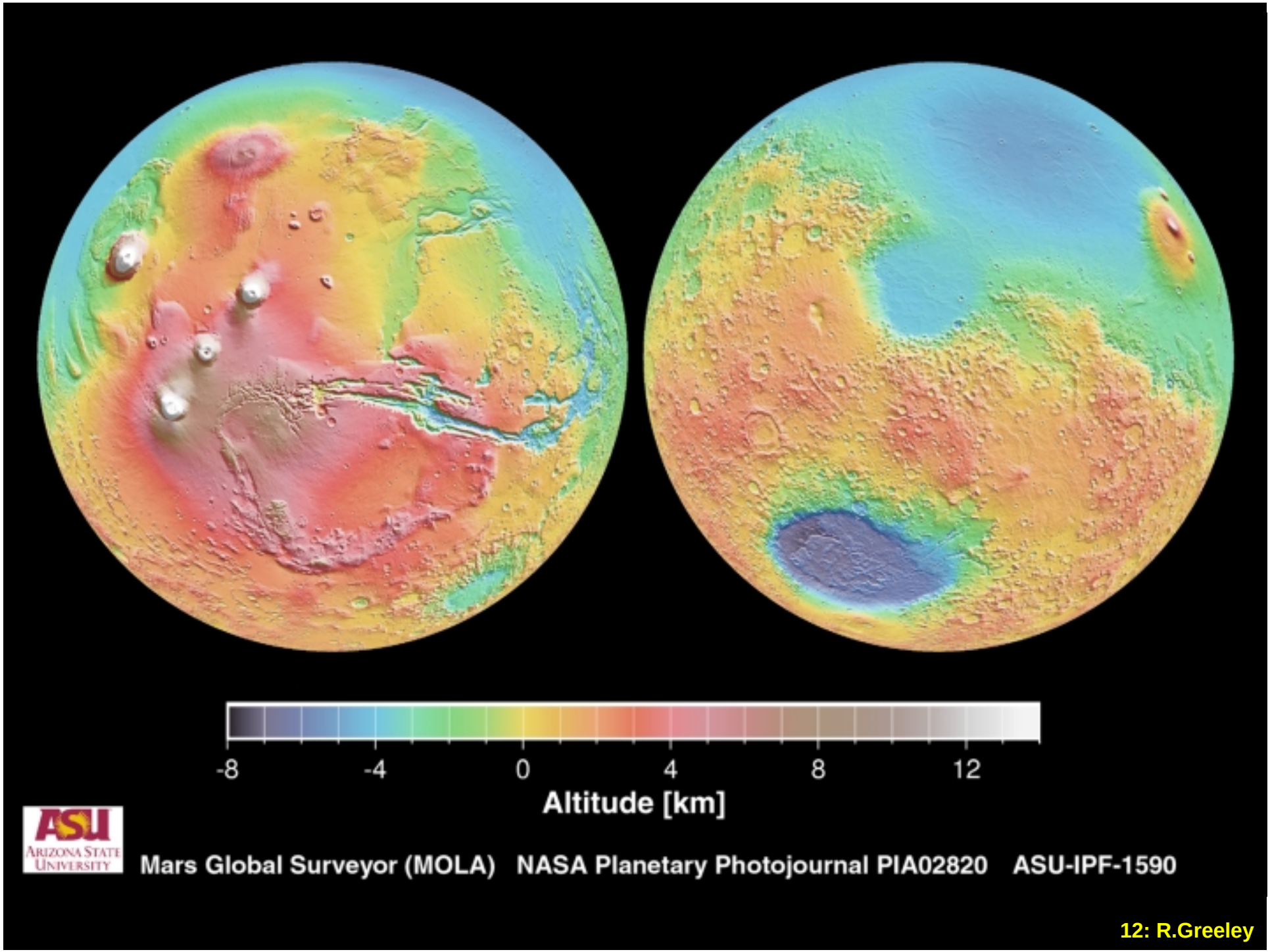
Do not design experiments that potentially lead to dead ends!

MARS PATHFINDER AND GLOBAL SURVEYOR (1996-)





11: R.Greeley


-8
-4
0
4
8
12
Altitude [km]
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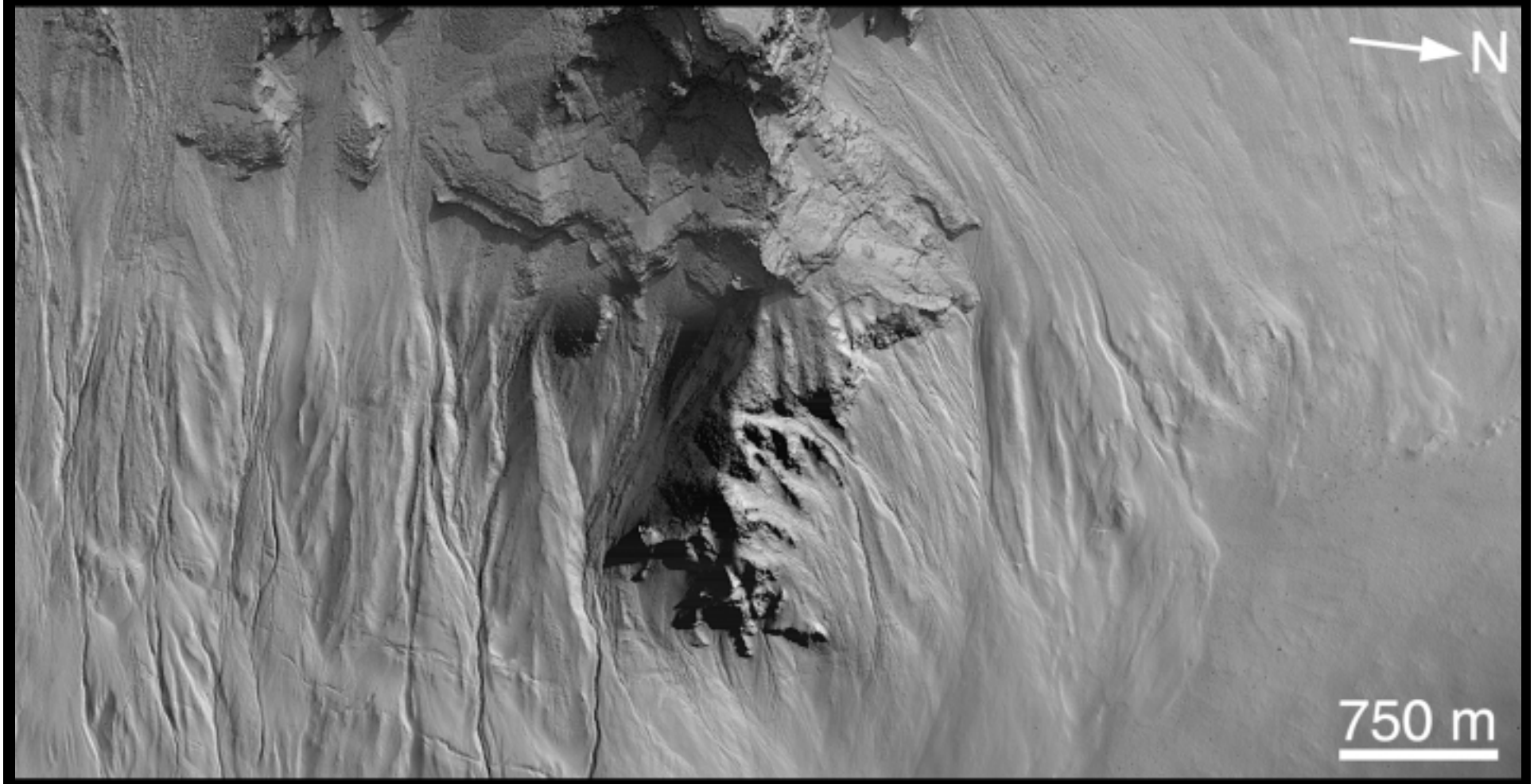
Mars Global Surveyor (MOLA) NASA Planetary Photojournal PIA02820 ASU-IPF-1590

12: R.Greeley

13: R.Greeley



Mars Global Surveyor (MOC) NASA Planetary Photojournal PIA03205 ASU-IPF-1591

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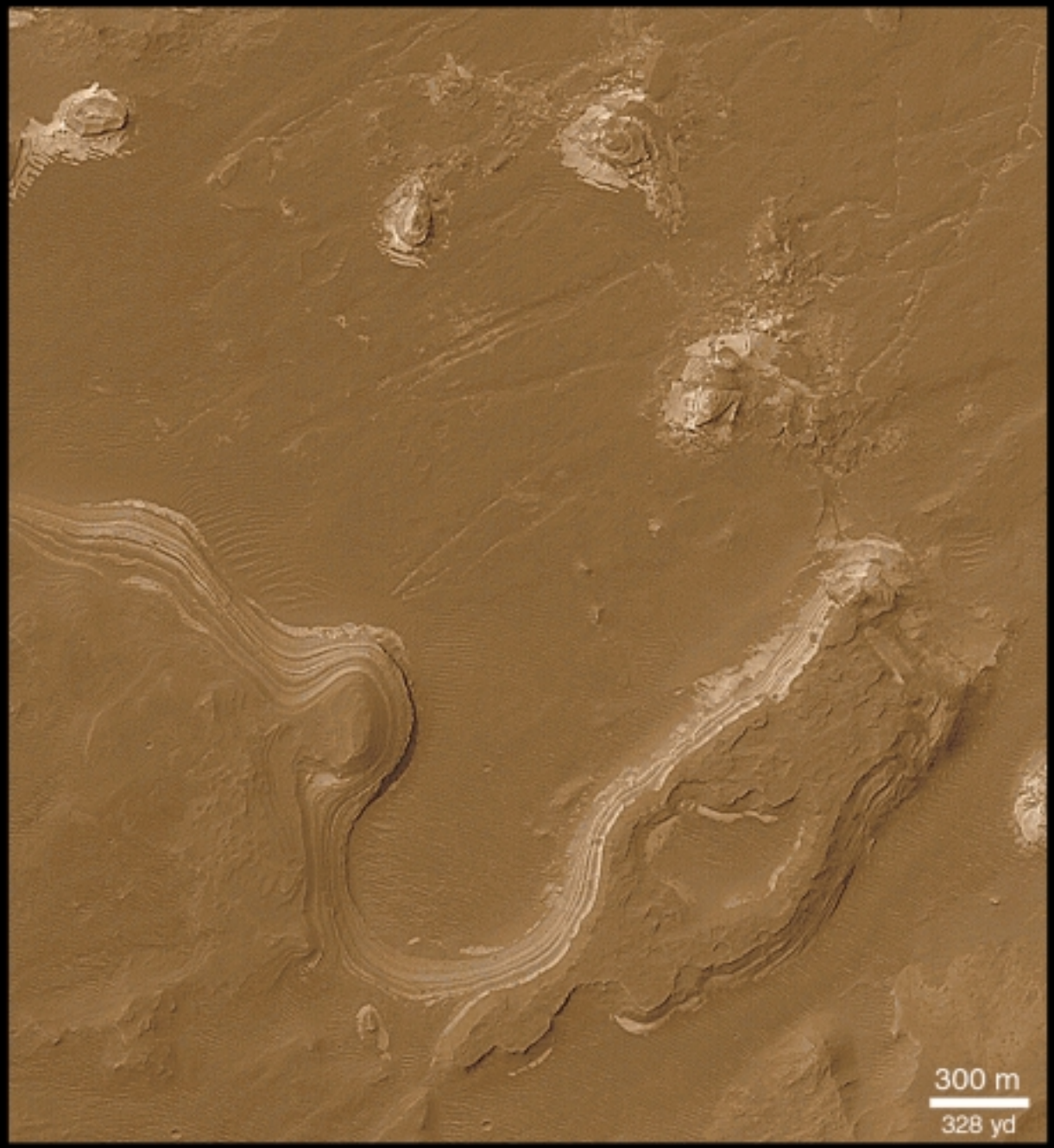
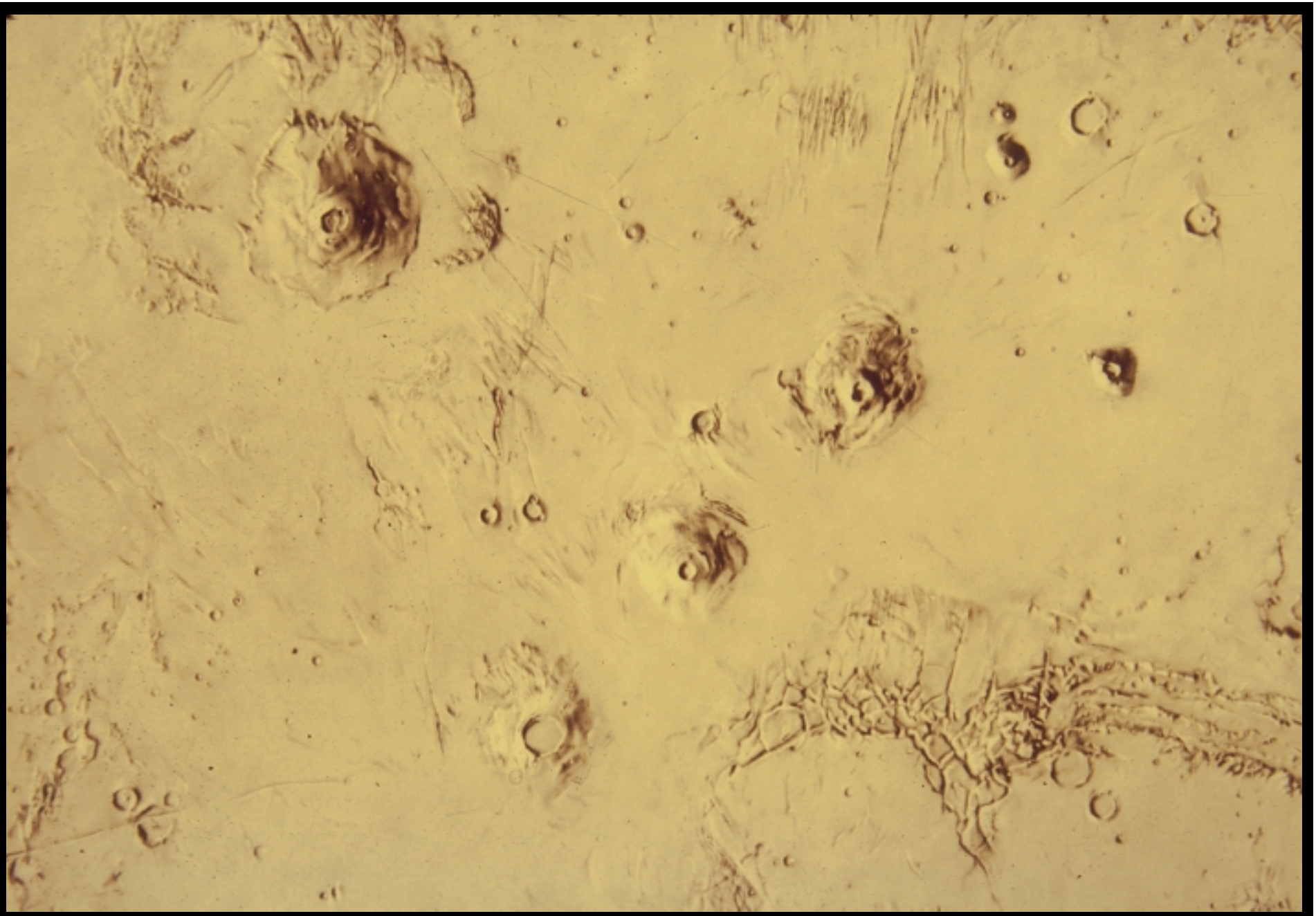


Mars Global Surveyor (MOC) NASA Planetary Photojournal PIA02846 ASU-IPF-1616

15: R.Greeley



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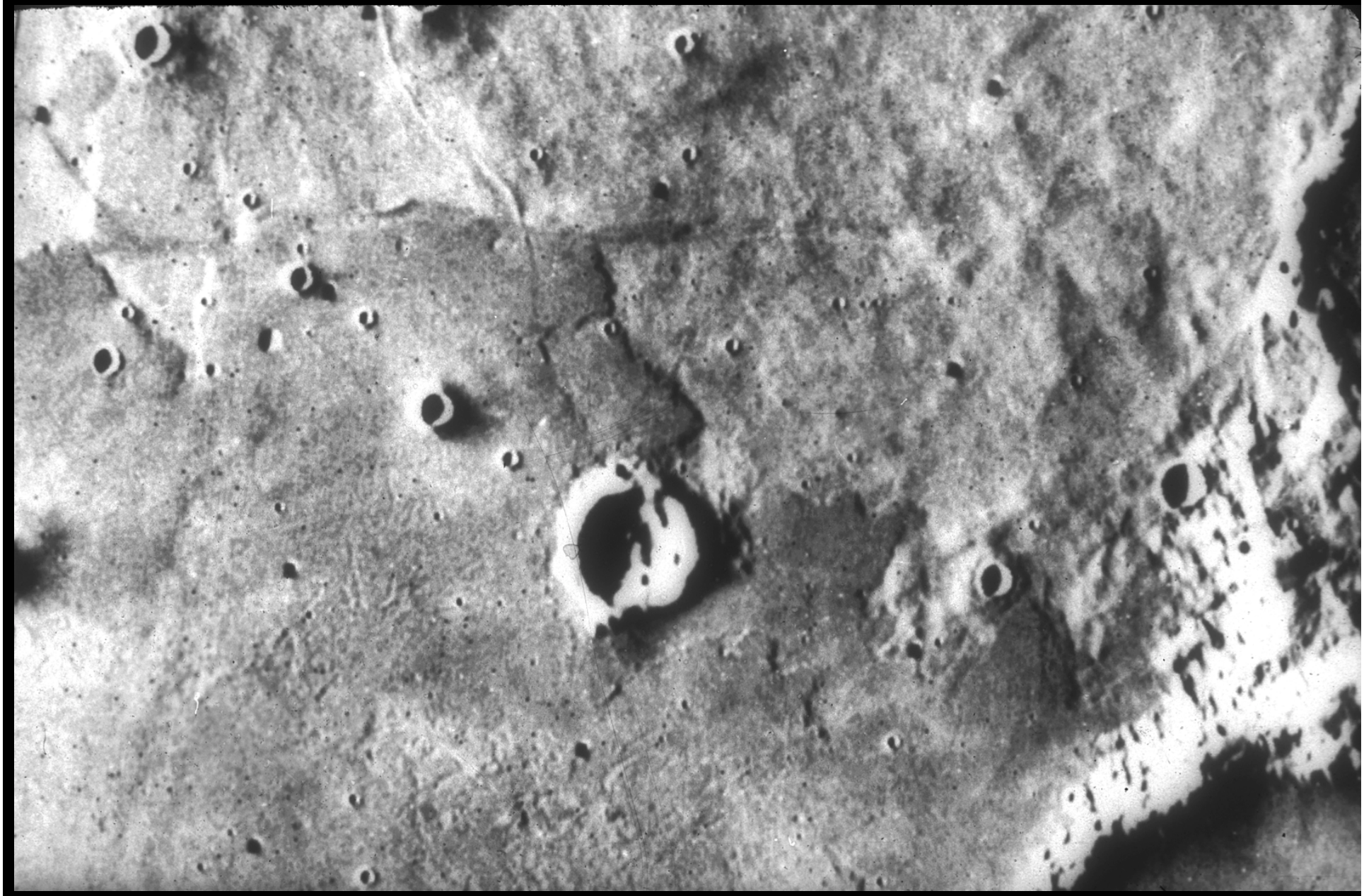
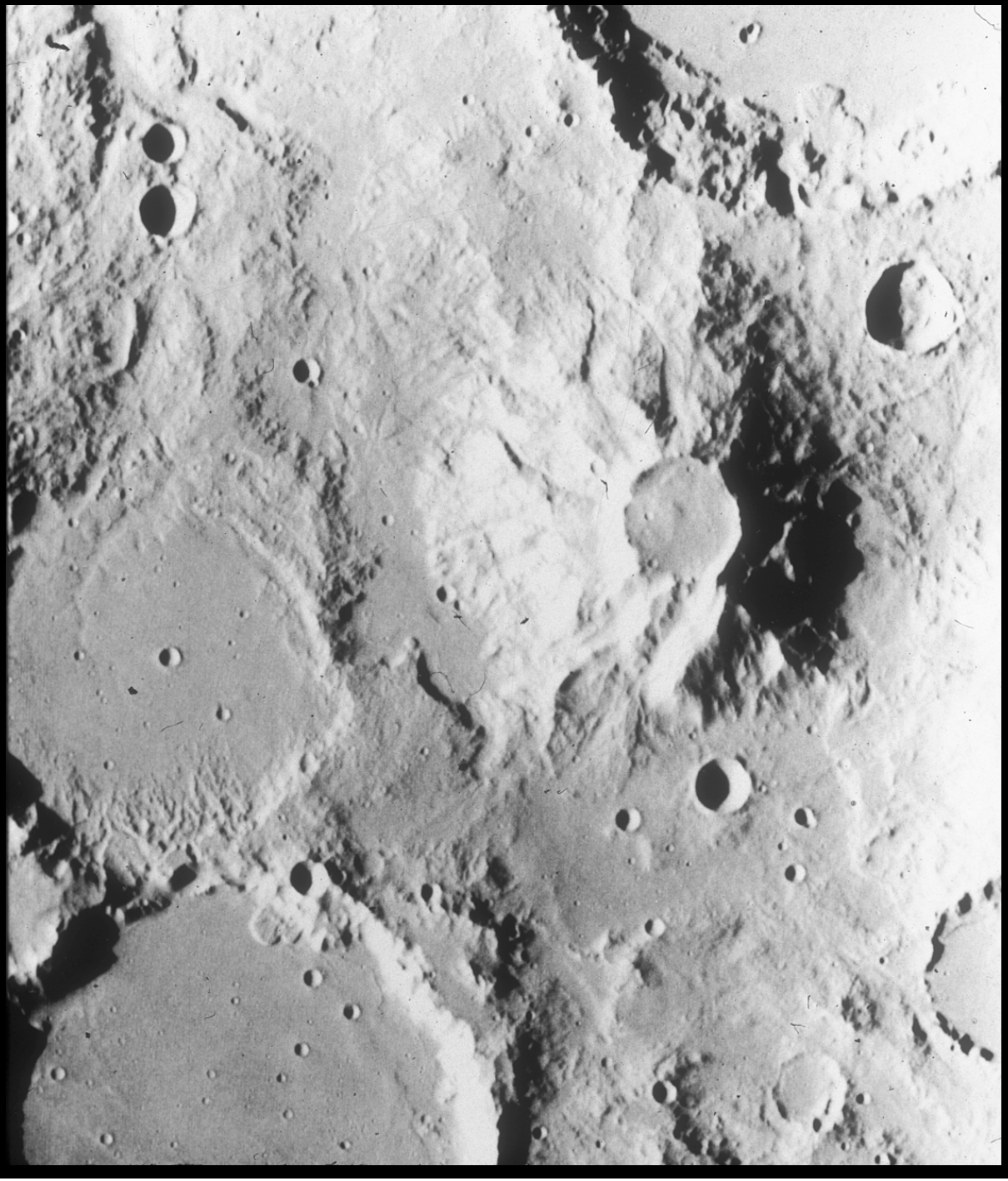
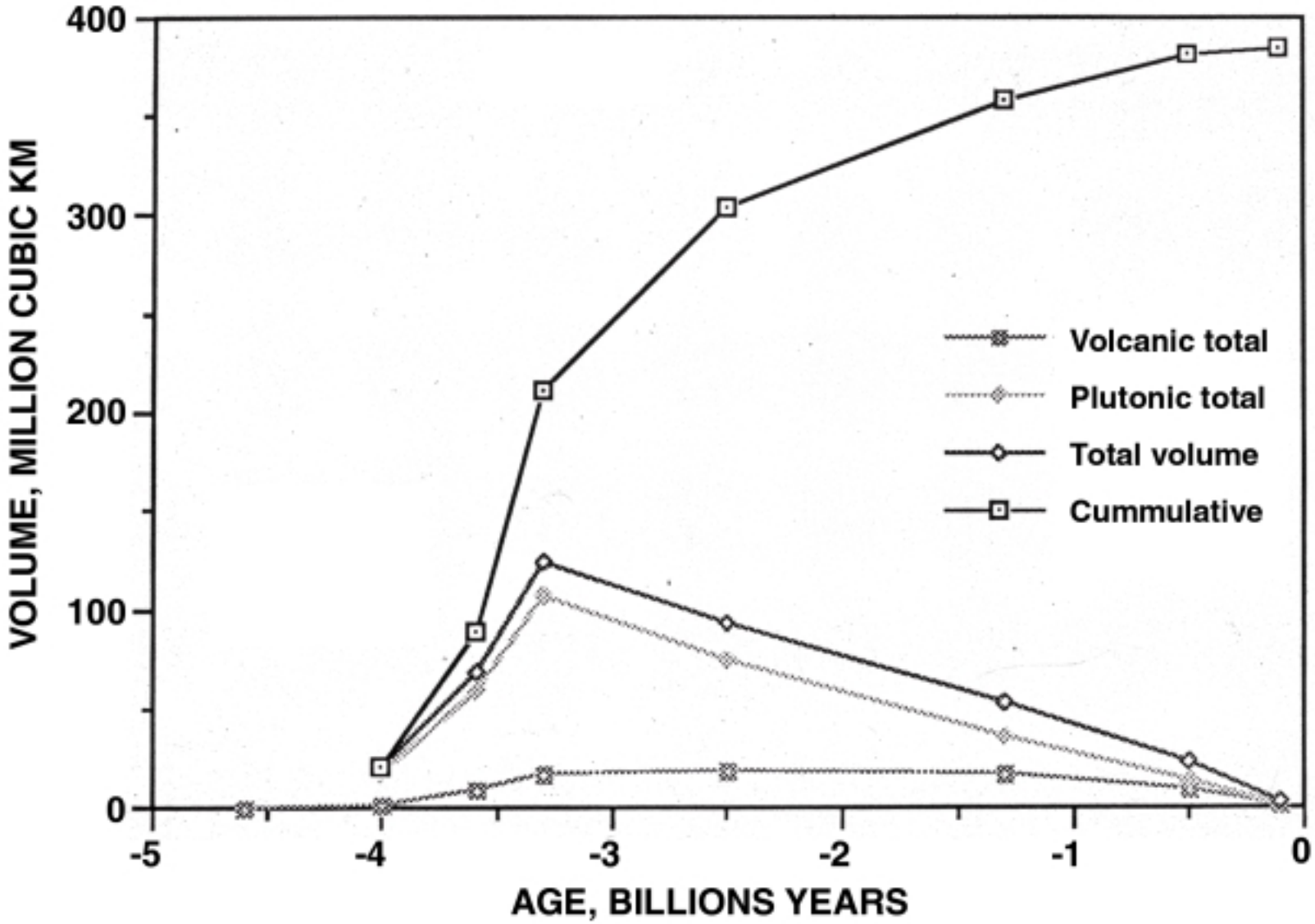


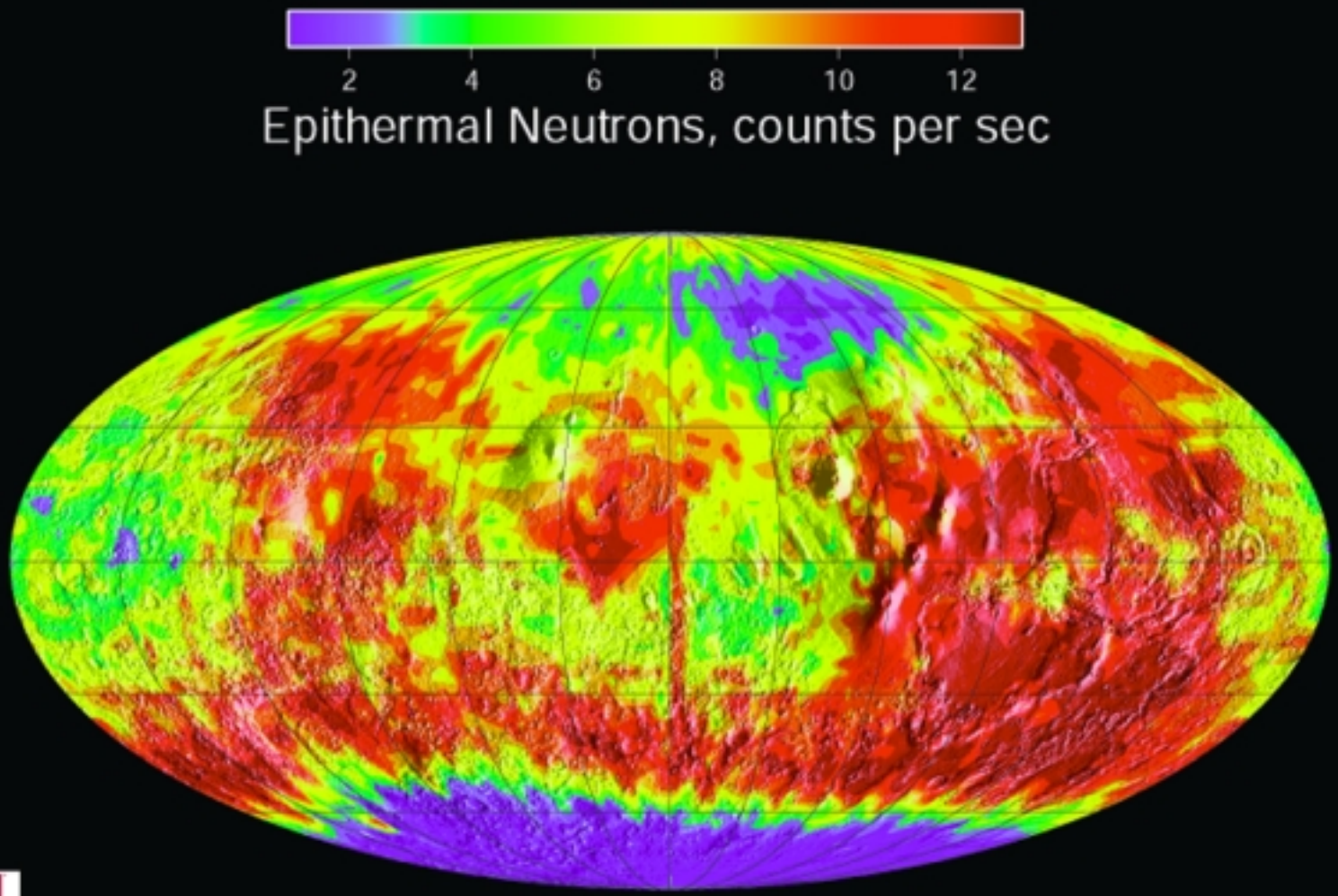
17: R.Greeley



18: R.Greeley

MARS MAGMA GENERATION




2
4
6
8
10
12
Epithermal Neutrons, counts per sec
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Arizona State University
GMT 2002 Feb 28 14:12:22

20: R.Greeley

Mars Global Surveyor (MOC) ASU-IPF-1238

NASA Planetary Photojournal PIA02006

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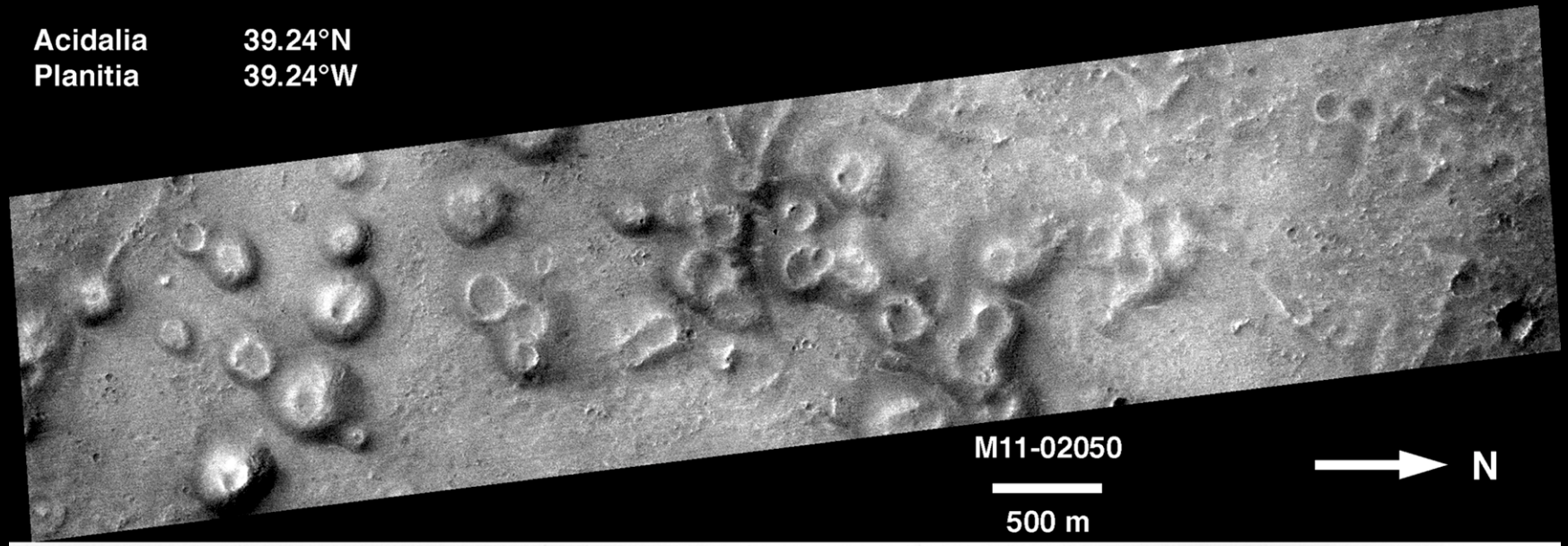
21: R.Greeley



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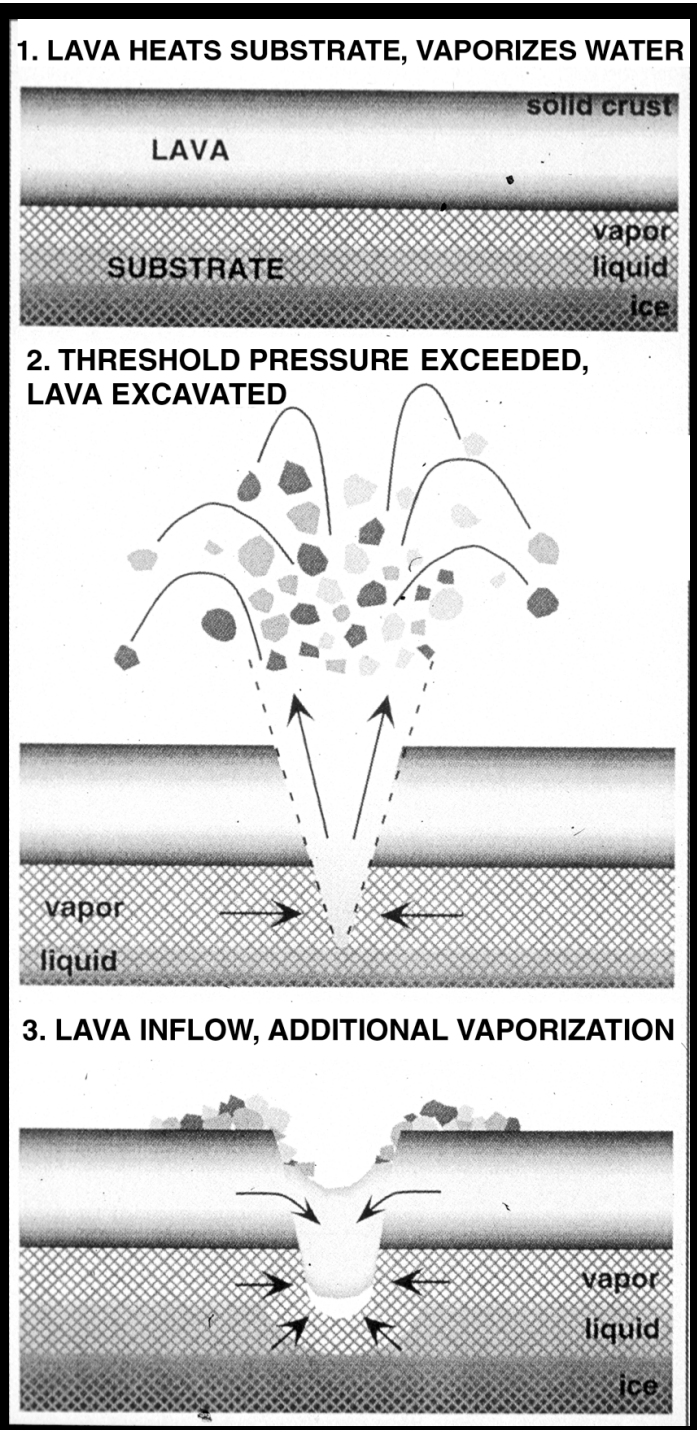
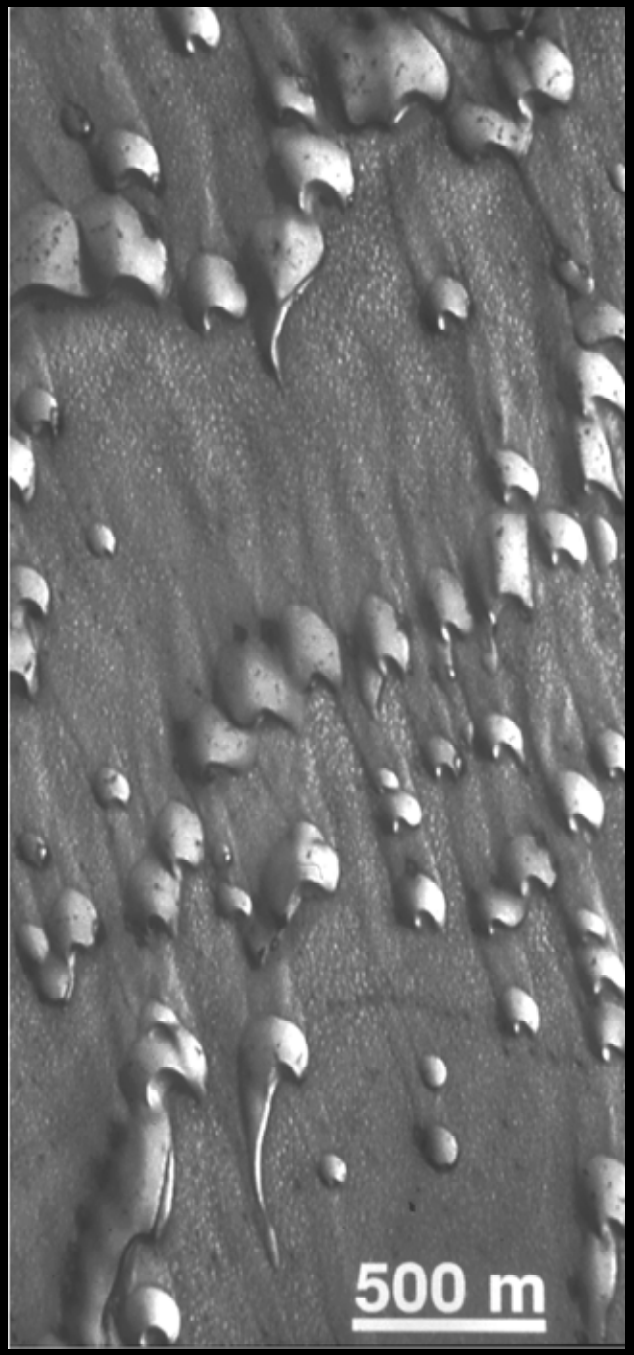
22: R.Greeley


1. LAVA HEATS SUBSTRATE, VAPORIZES WATER
solid crust
LAVA
vapor
SUBSTRATE
liquid
ice
2. THRESHOLD PRESSURE EXCEEDED, LAVA EXCAVATED
vapor
liquid
3. LAVA INFLOW, ADDITIONAL VAPORIZATION
vapor
liquid
ice



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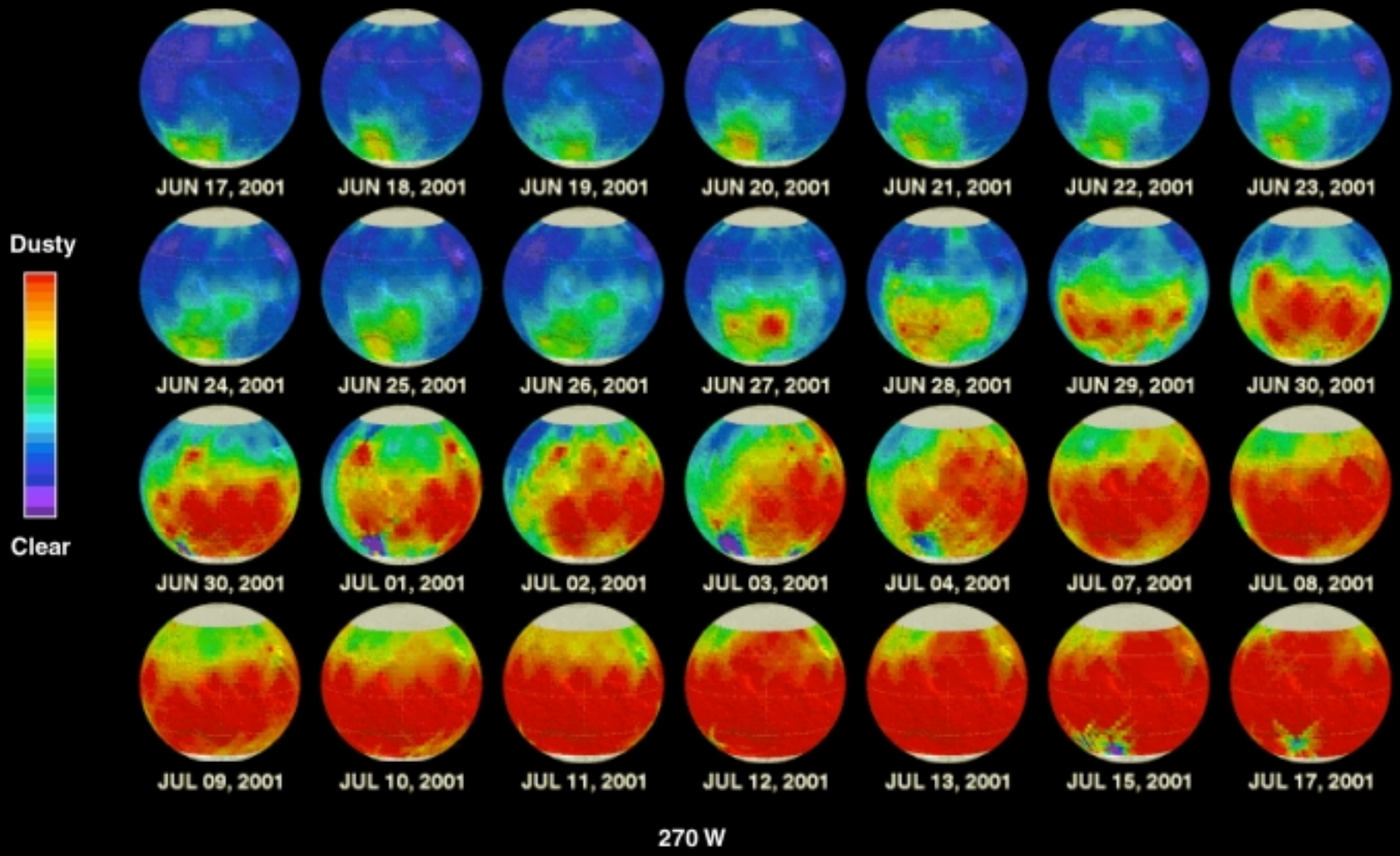
Martian Dust Storm Activity



Mars Global Surveyor - Thermal Emission Spectrometer NASA TES Team - Dust Frame ASU-IPF-1662

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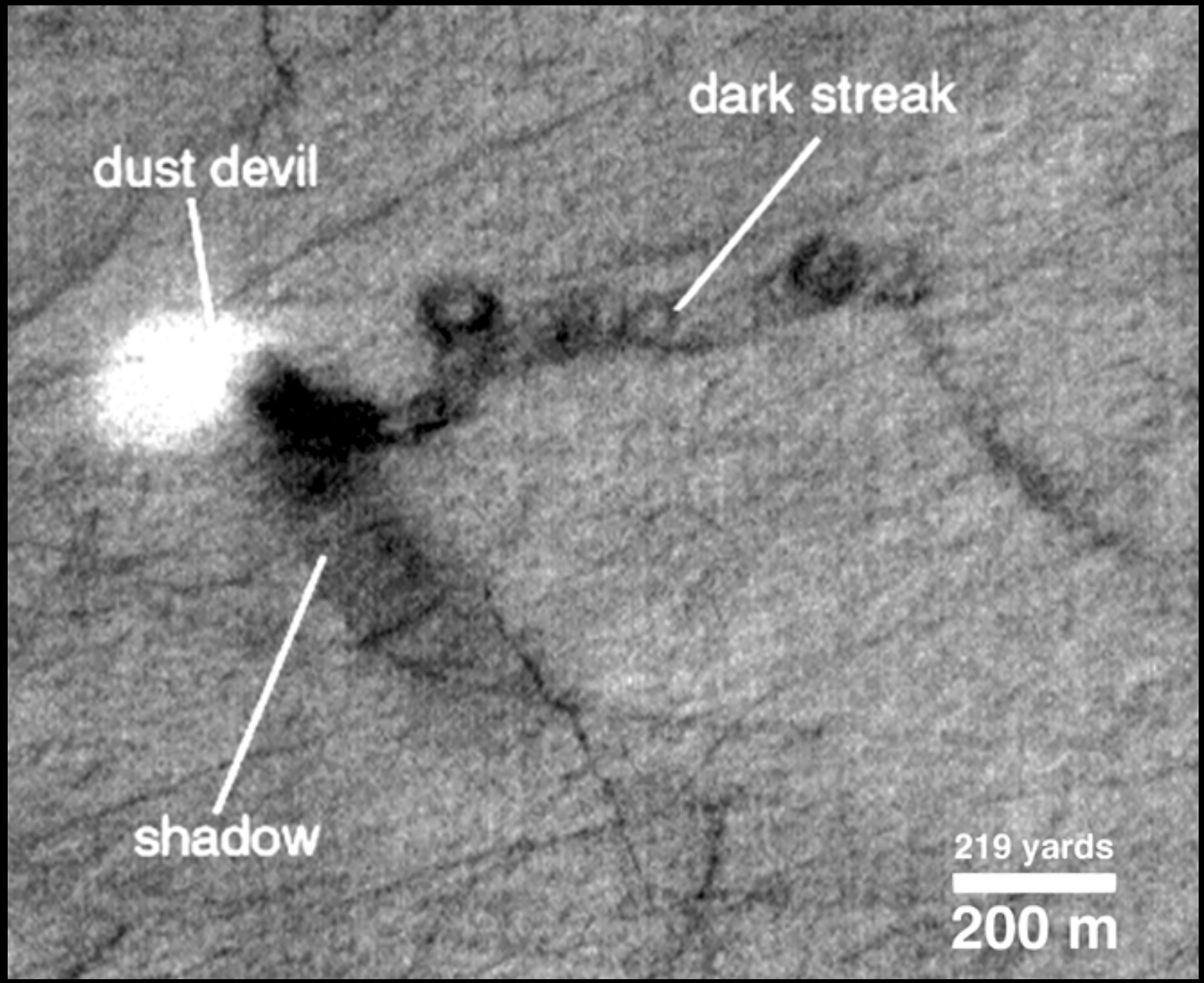

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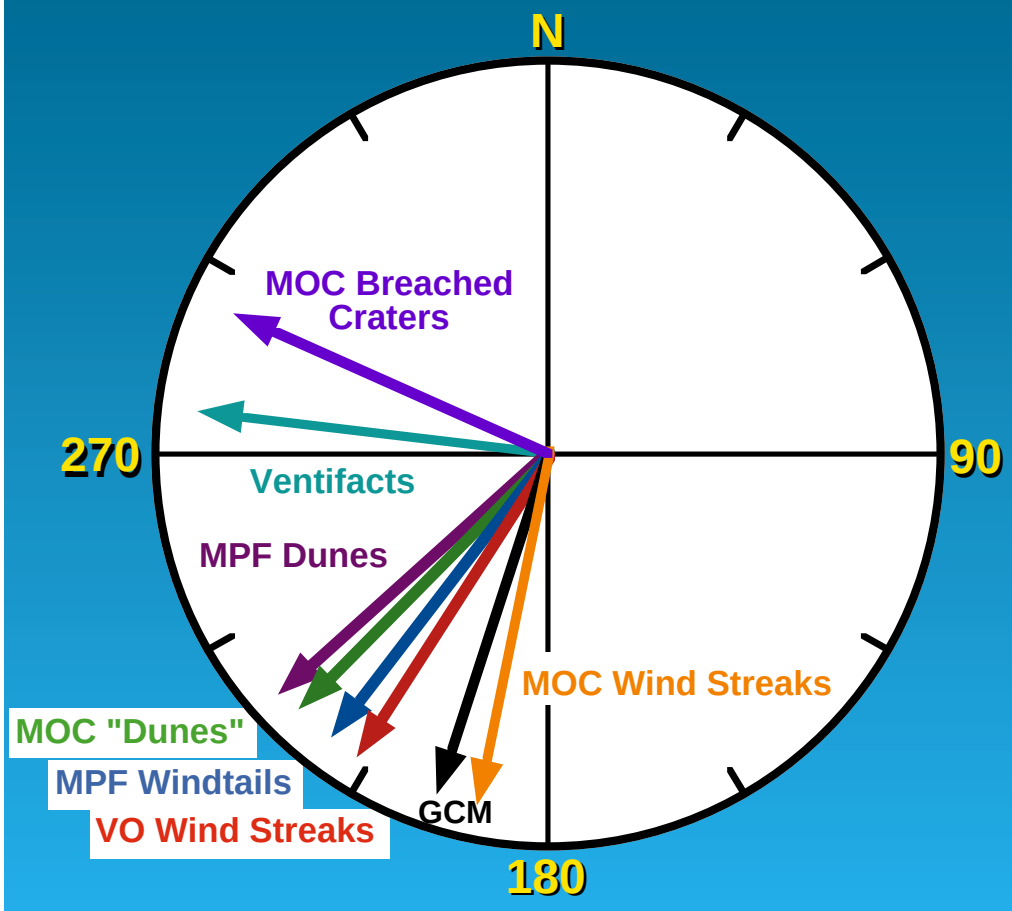
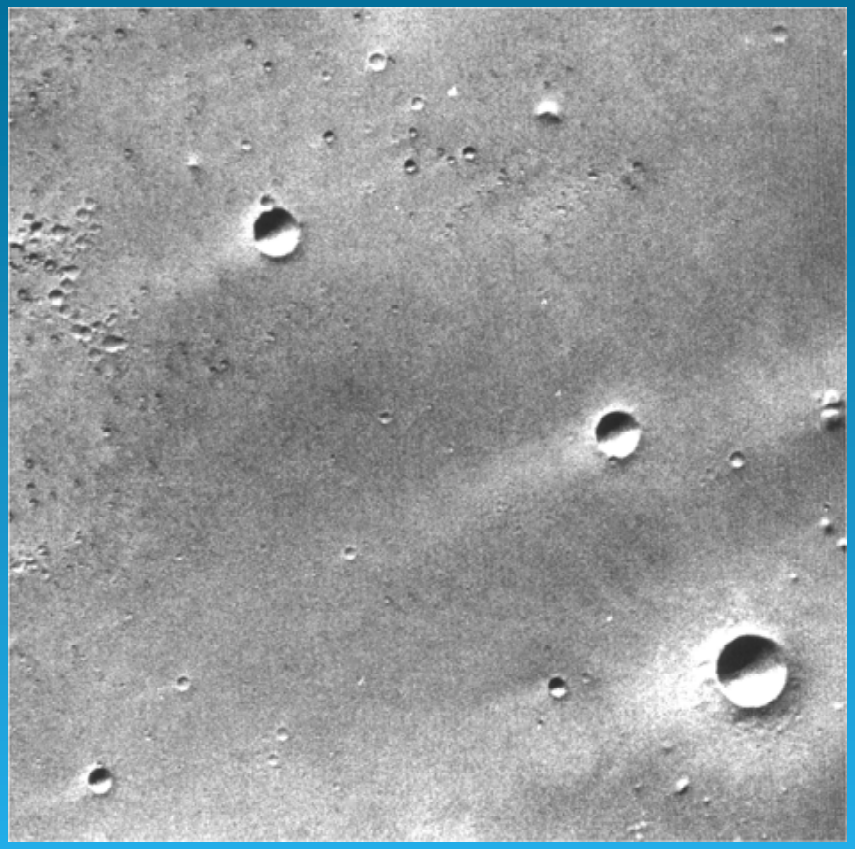
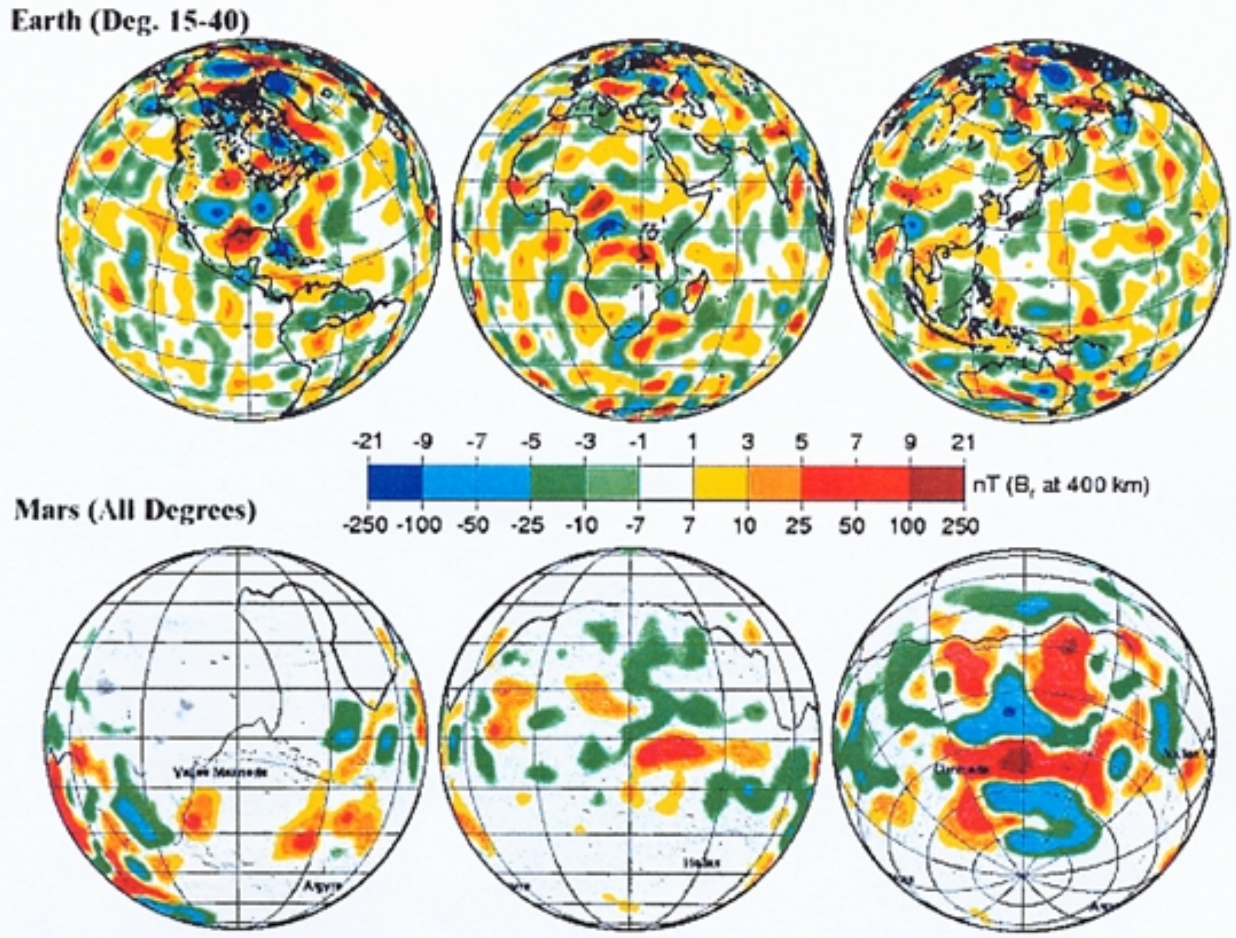
PATHFINDER AND ORBITER DATA





MARS EXPLORATION PROGRAM

New Magnetic Map of Earth vs. Mars



Crust of Mars is enriched in ferromagnetic materials in certain places (relative to Earth).

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MESSAGE!

"NEW" INCREASES THE <u>POTENTIAL FOR DISCOVERIES</u>

- **NEW AREAS NEVER SEEN (IN SPACE OR IN RESOLUTION)**
- **NEW INSTRUMENTS; NEW TYPES OF DATA**
- **SAMPLES FOR STUDY IN EARTH LABORATORIES**

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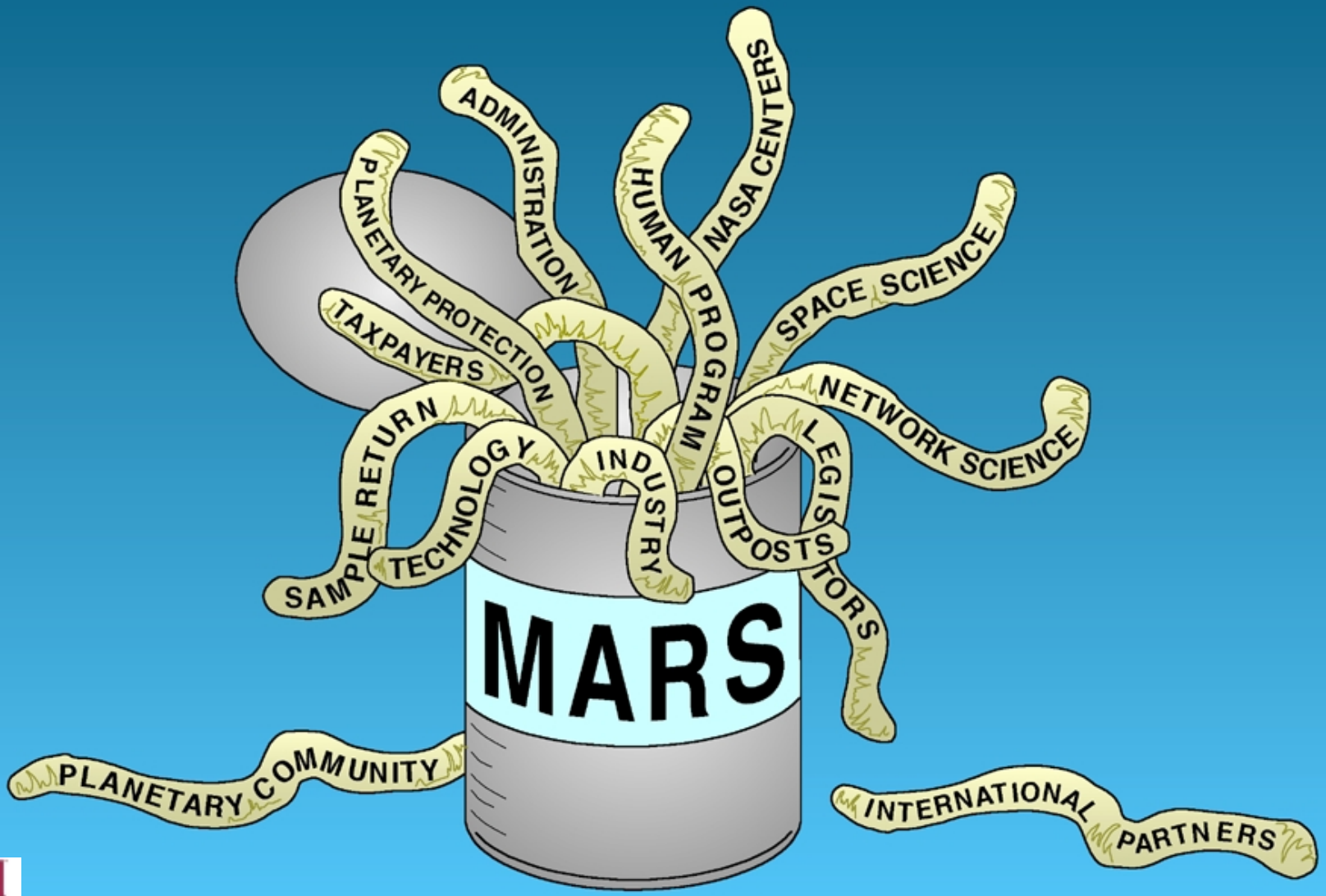
MARS EXPLORATION PROGRAM ANALYSIS GROUP



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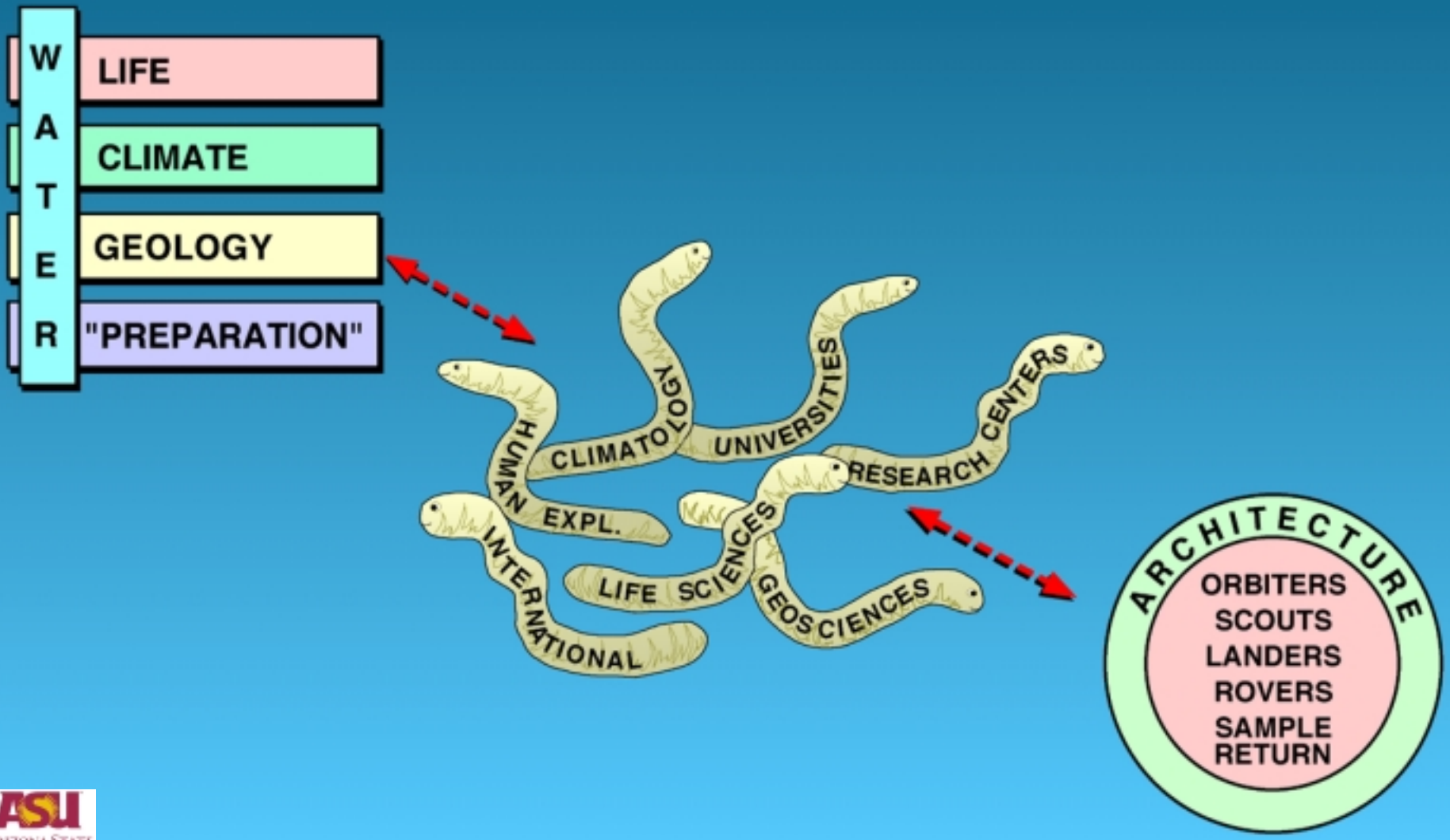
WE NEED TO PROVIDE THE CONNECTIVITY



MARS EXPLORATION PROGRAM

Goal: **Determine if *life* ever arose on Mars**

Objective A: **Determine if life exists *today***

Objective B: **Determine if life existed on Mars in the *past***

Objective C: **Assess the extent of *prebiotic organic chemical evolution* on Mars**

Goal: **Determine *climate* on Mars**

Objective A: **Characterize Mars' *present* climate and climate processes**

Objective B: **Characterize Mars' *ancient* climate and climate processes**

Goal: **Determine the evolution of the surface and interior of Mars ("*geology*")**

Objective A: **Determine the nature and sequence of the various *geologic processes* (volcanism, impact, sedimentation, alteration etc.) that have resulted in formation of the Martian crust and surface**

Objective B: **Characterize the structure, dynamics, and history of Mars' *interior***

Goal: ***Prepare* for human exploration**

Objective A: **Acquire Martian *environmental* data sets**

Objective B: **Conduct in-situ engineering-science *demonstrations***

Objective C: **Emplace *infrastructure* for future missions**

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MEPAG "WHITE PAPER" HIERARCHY

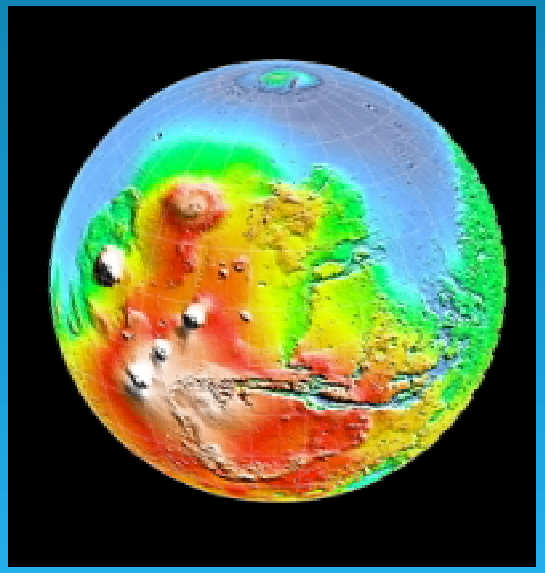
http://mmolib.jpl.nasa.gov/mepag.html

I. Broad programmatic *goals*

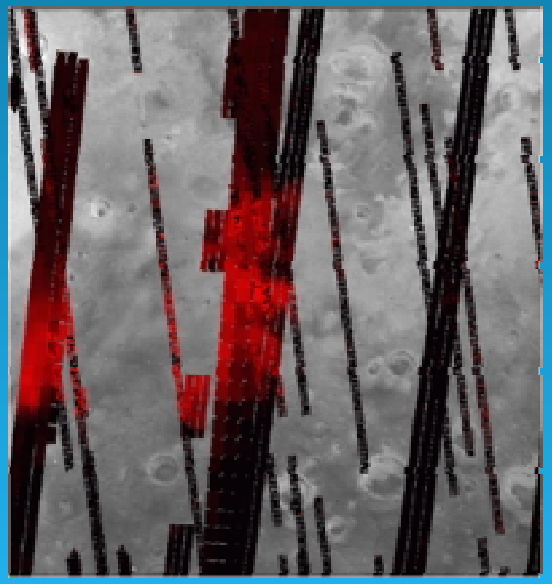
A. Series of *objectives* to meet each goal

1. *Investigations* needed for each objective

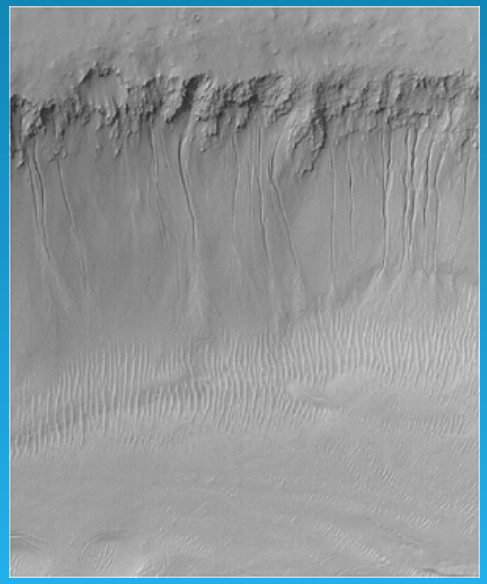
a) Specific *measurements* to carry out investigations



Topography



Mineralogy

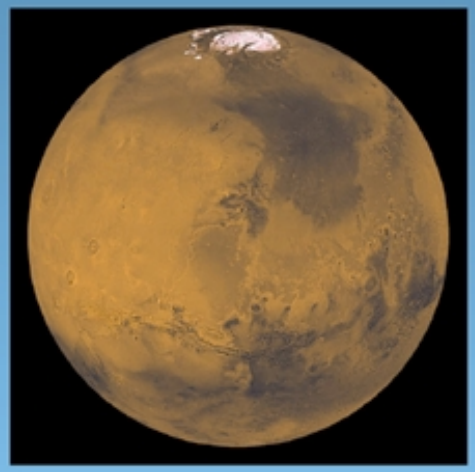


Geomorphology

THE MARS EXPLORATION PYRAMID

SAMPLE RETURN

SEARCH



IN SITU

INSTRUMENT/INVESTIGATION DEVELOPMENT/TESTING

DATA ANALYSIS

SAMPLE HANDLING

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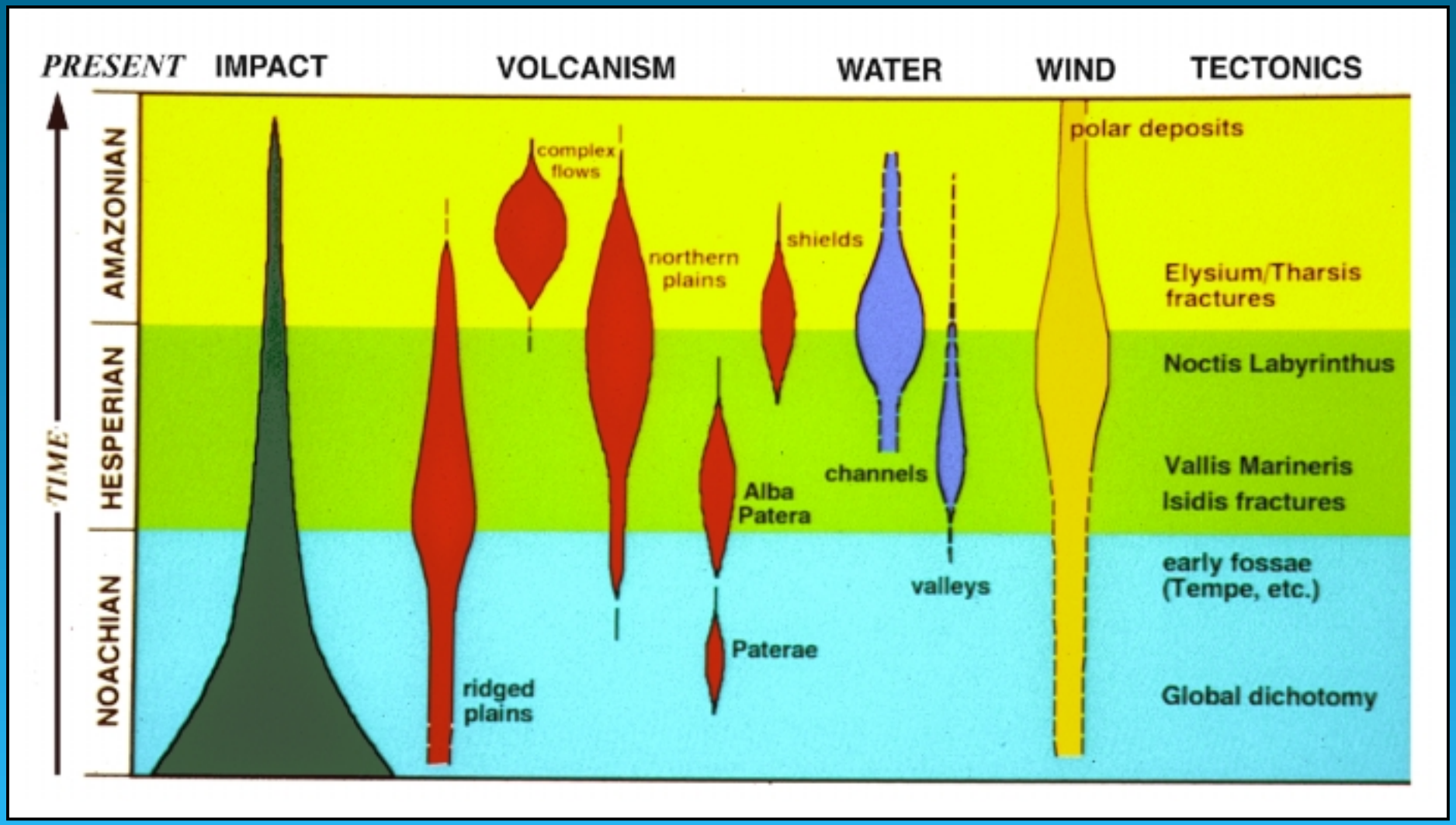
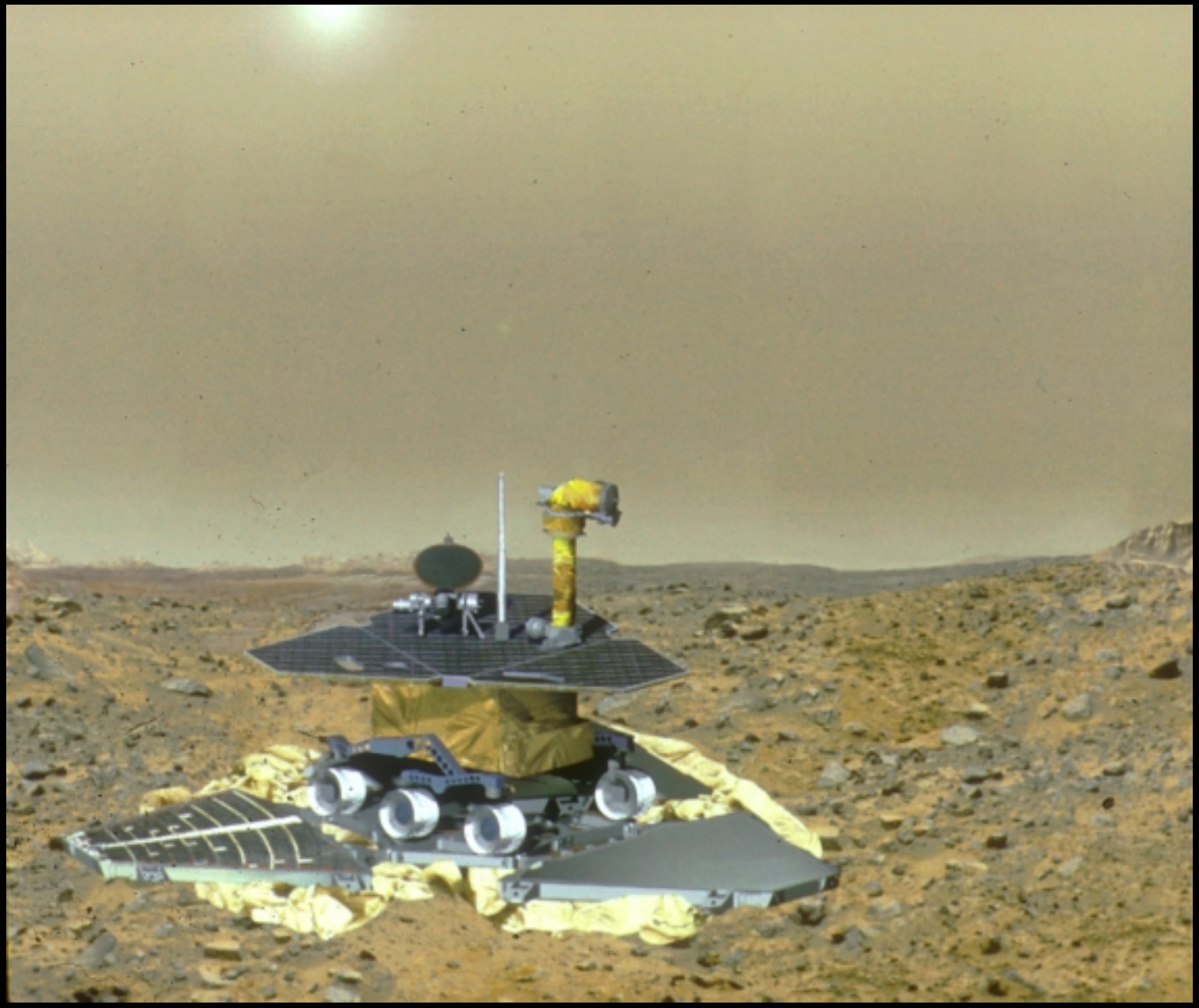
GEOLOGIC HISTORY OF MARS





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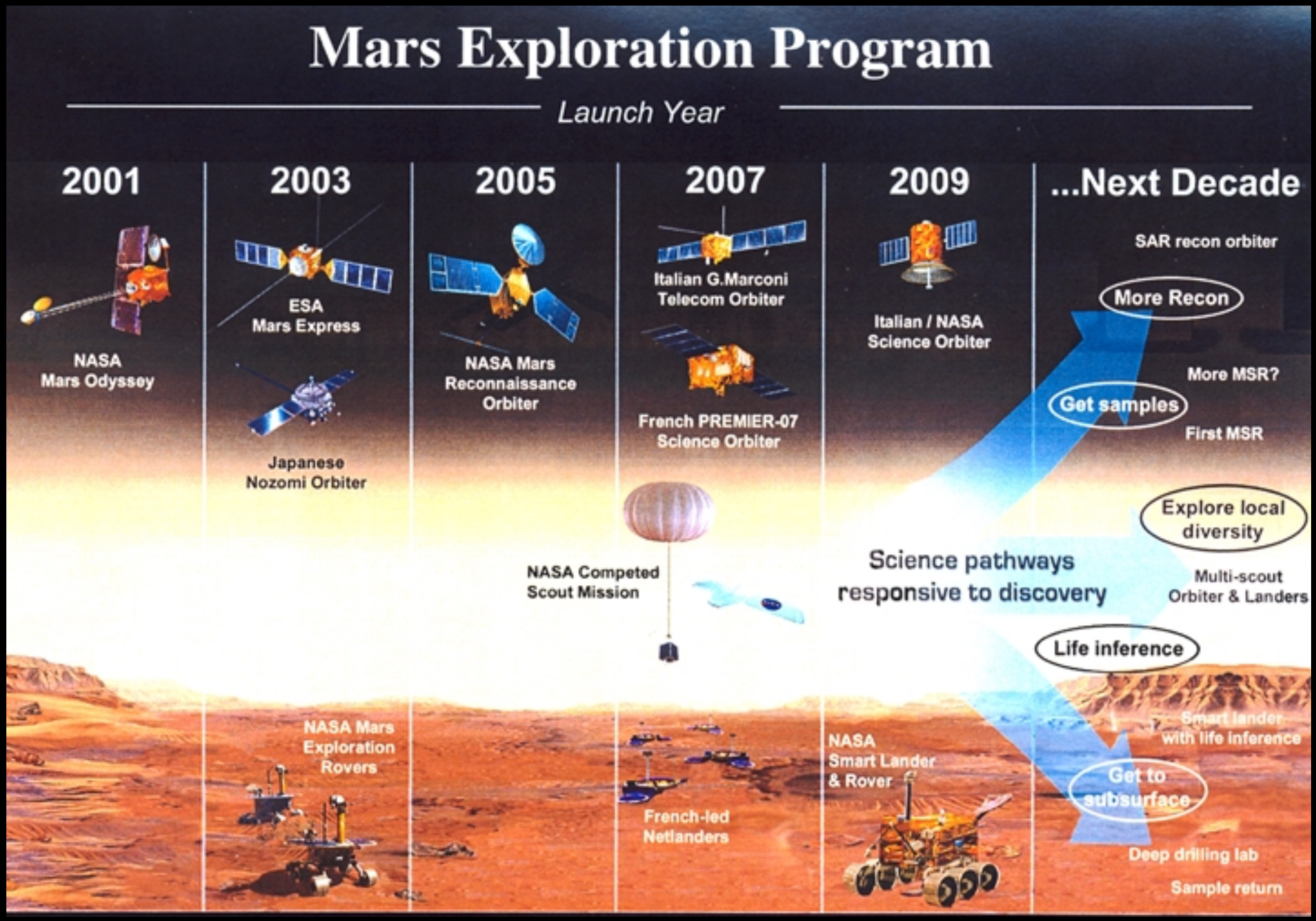
36: R.Greeley

37: R.Greeley



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