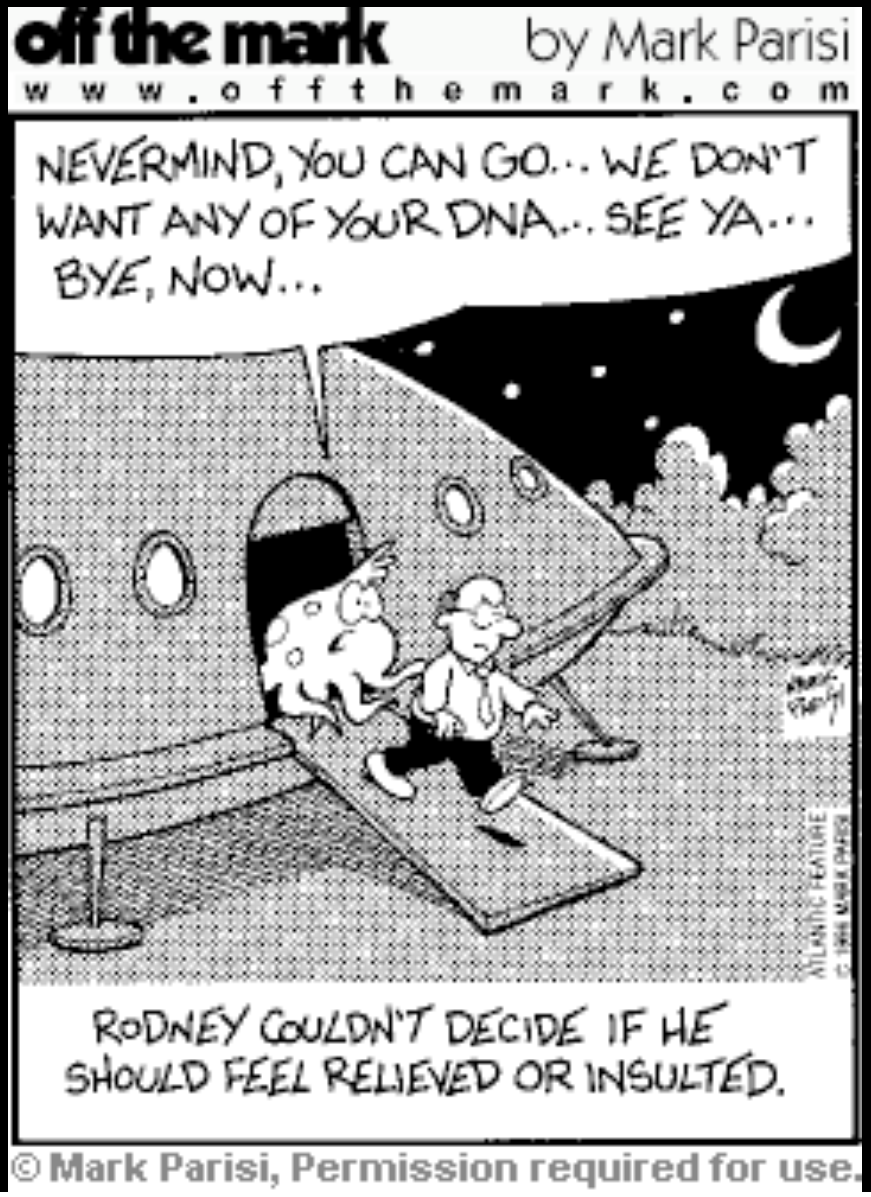
ASTR 380
Possibilities for Life on Mars



Possibilities for Life in the Inner Solar System

Last Lecture: Venus
This Lecture: Mars – Chapter 8

We are examining the possibilities in these lectures.

- Seeing what existing evidence says
- What we can infer
- Few 100% conclusions

Possibility of Life in the Inner Solar System

Venus versus our checklist:

chemical building blocks: Earth-like origin. Lots of C, N, O.
But currently low on water!

energy: reasonable sunlight. Hot temperatures a problem
for Earth type complex molecules

liquid: No. Too hot for water

stability: Very hot and dry now. Surface may
have episodes of extreme volcanic activity.

Very poor chance for current life.
Small chance of life in the past.

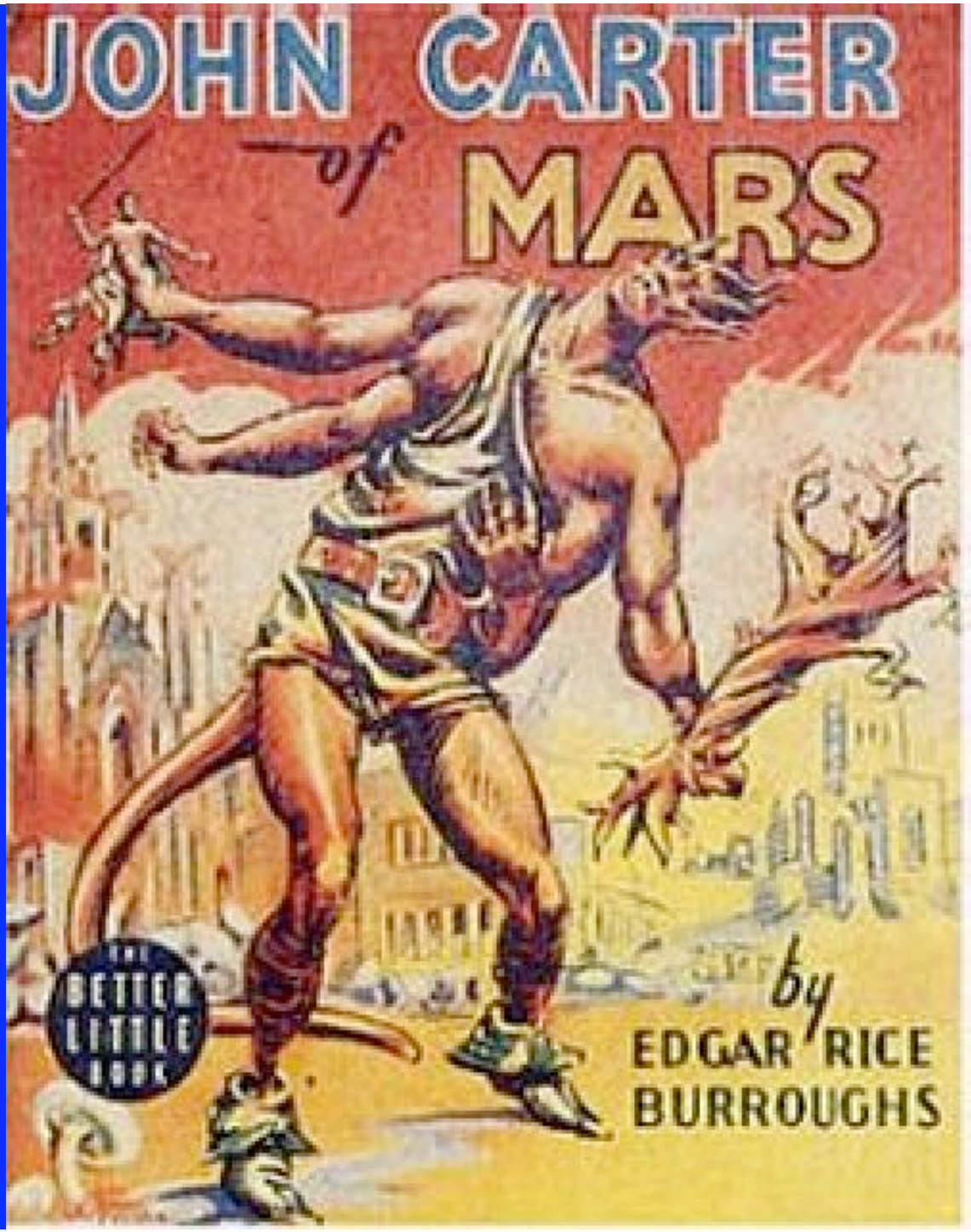
EDGAR RICE BURROUGHS
A PRINCESS OF MARS

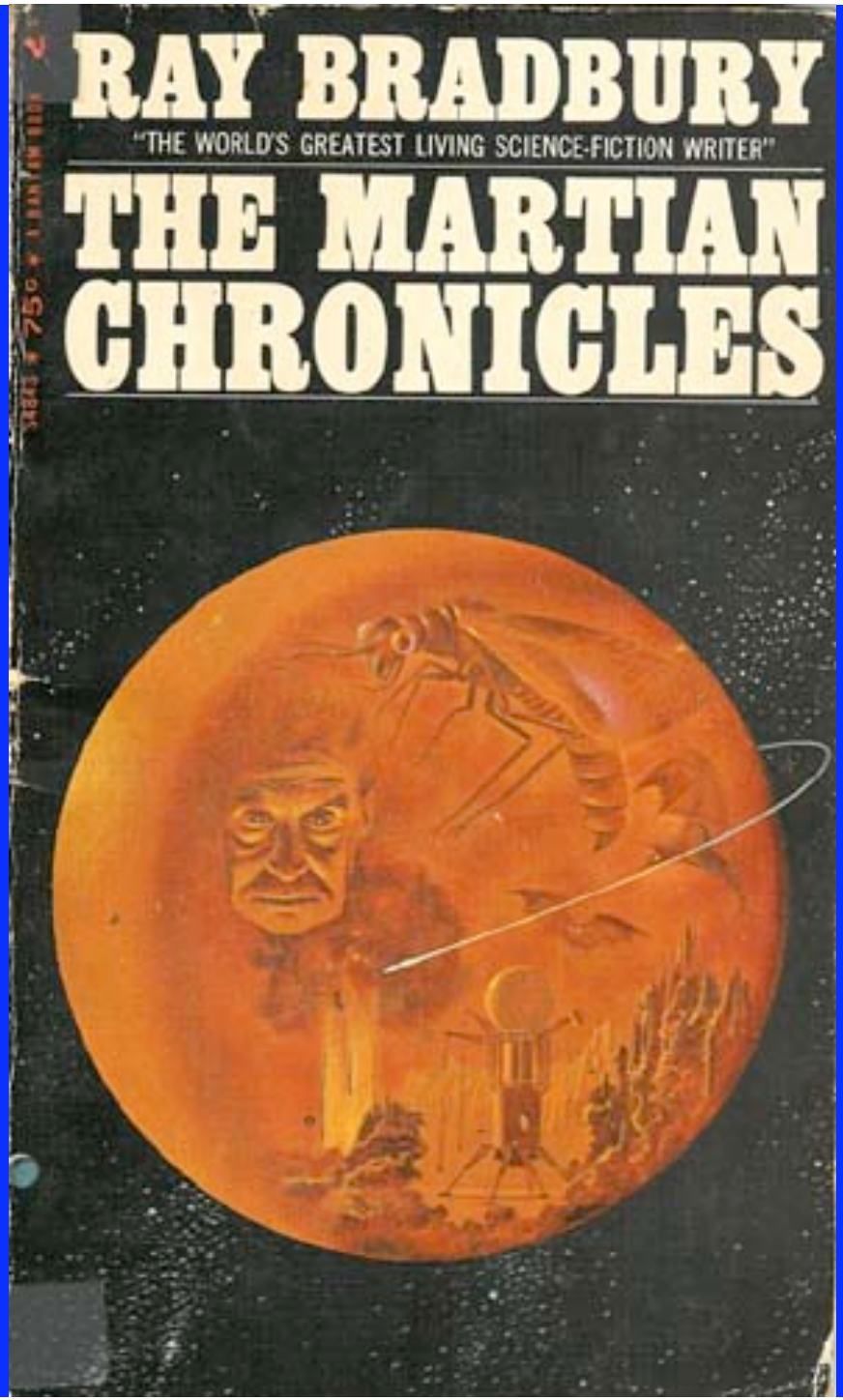
READ BY JOHN BOLEN

Tantor Media

COMPACT disc DIGITAL AUDIO

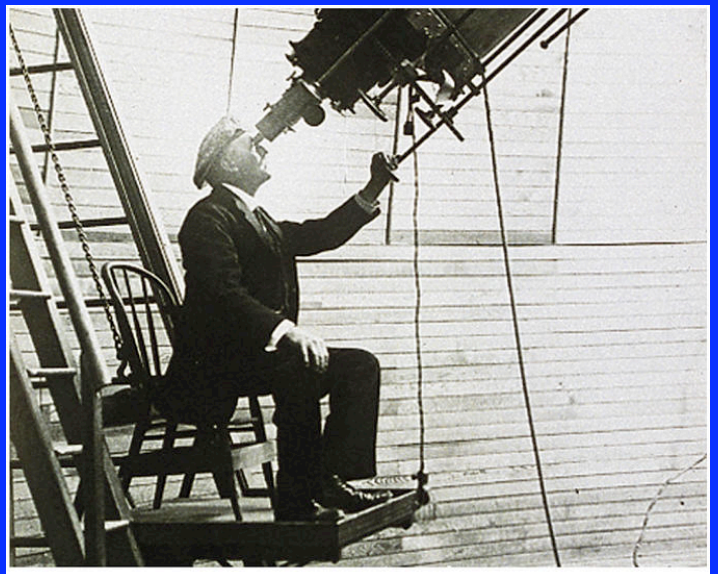
UNABRIDGED *Classics*


JOHN CARTER
of
MARS
by
EDGAR RICE
BURROUGHS

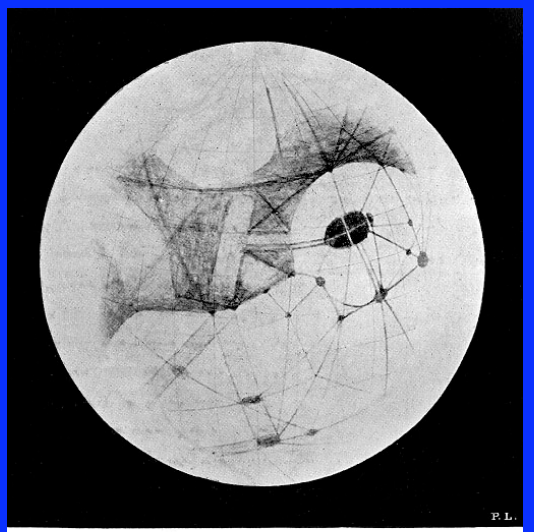

RAY BRADBURY
"THE WORLD'S GREATEST LIVING SCIENCE-FICTION WRITER"
THE MARTIAN CHRONICLES

Percival Lowell and Canals

- From rich Boston family
- Read Schiaperelli: "canali" on Mars
- Excited, he constructed observatory in Arizona
- Saw many features; canals?
- Caught public attention, but might have been Lowell's retina!



(Lowell Observatory)



MARS

LONGITUDE 60° ON THE MERIDIAN

Orson Welles Radio Broadcast

- October 30, 1938
- Described clearly at beginning and intermission as play
- But presented as on the spot news
- Thousands of people thought we were being invaded

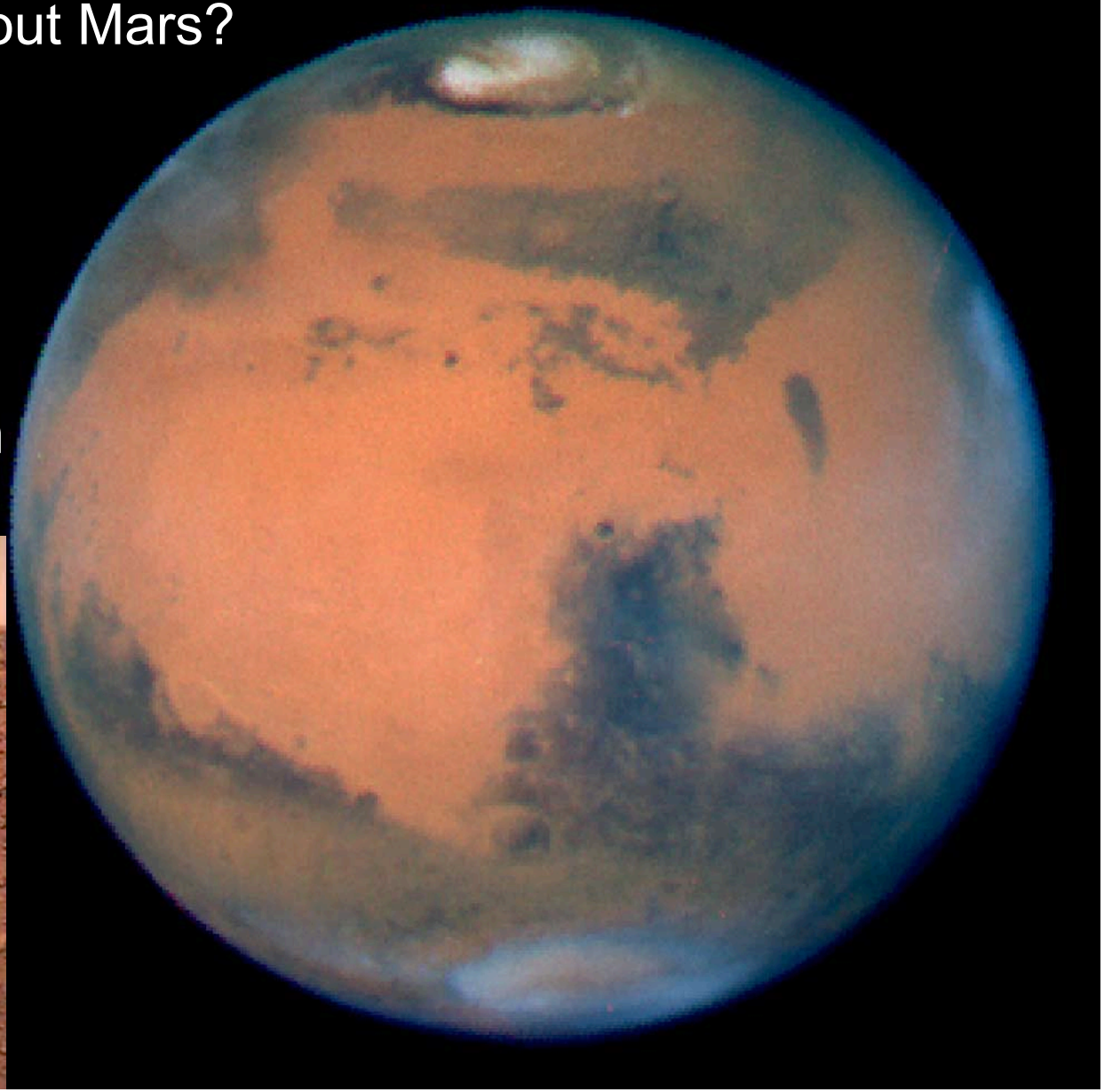
http://trusworld.com/alb/welles.jpg

Possibility of Life on Mars

What do we know about Mars?

- Rocky surface
- Thin atmosphere
- “ice” on poles
- Dust storms

Less mass than Earth



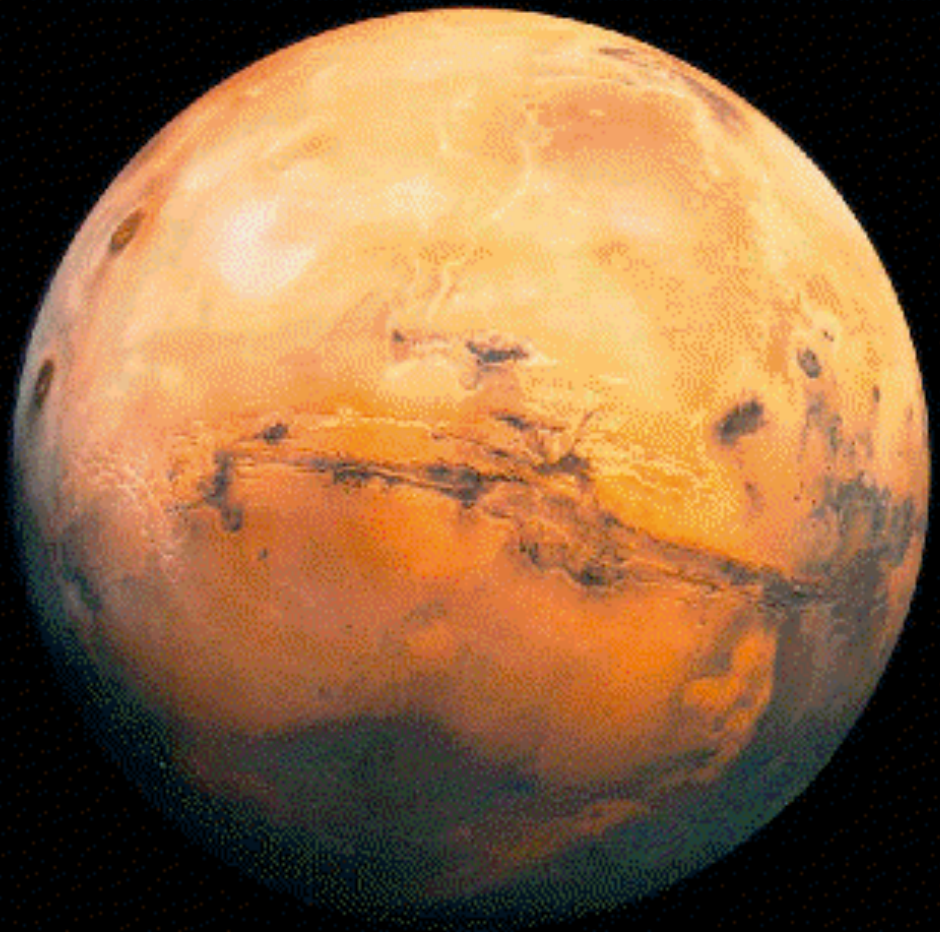
Possibility of Life on Mars

Mars Global Surveyor Project

Simple Facts About Mars

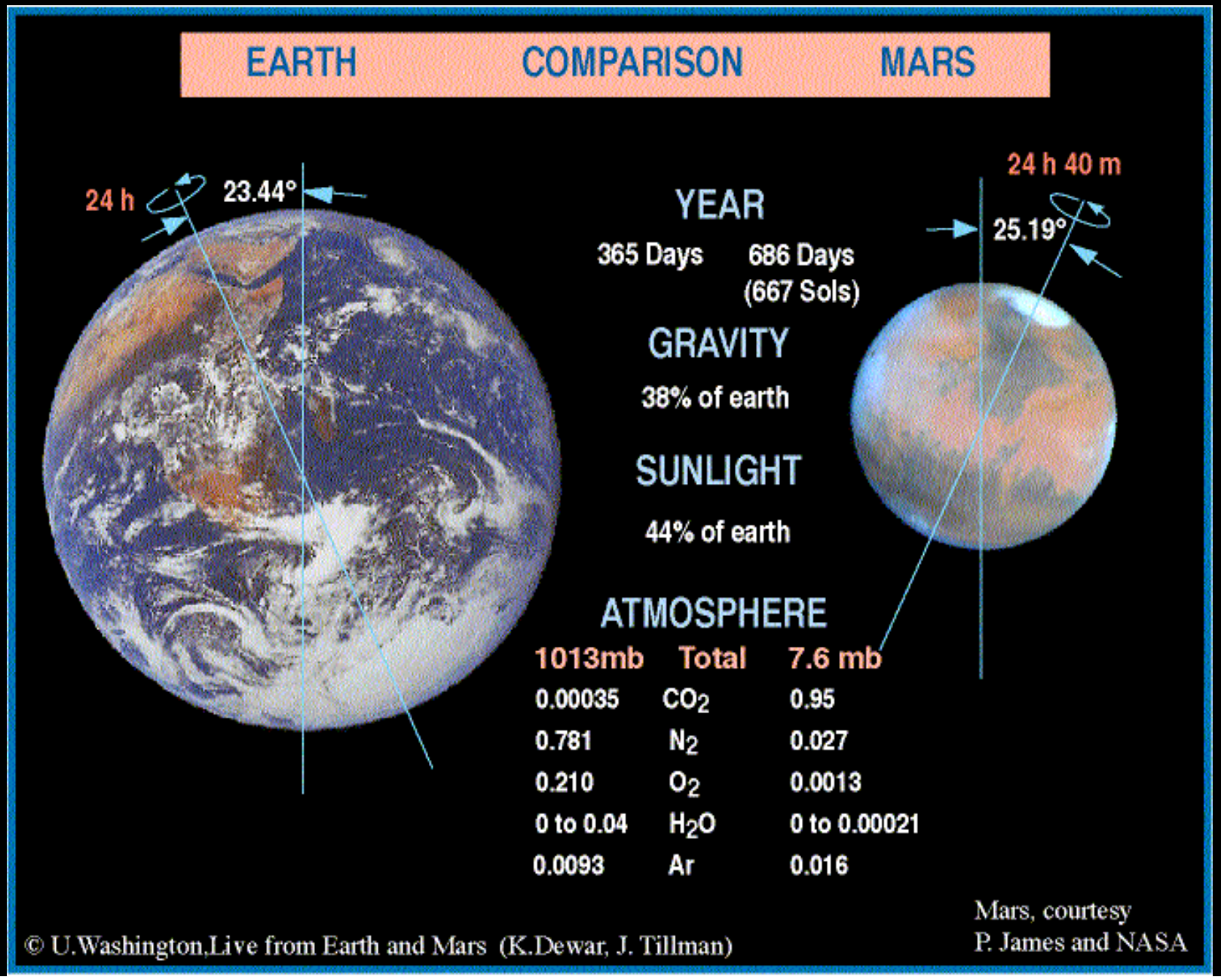
JPL

NASA



Diameter:	6,794 km (53% of Earth)
Mars Day:	24 hrs, 37 min
Mars Year:	687 Earth Days
Mass:	11% of Earth
Gravity:	38% of Earth
Atmosphere:	95% Carbon Dioxide, 3% NItrogen
Atmospheric Pressure:	1% of Earth's Sea Level
Temperature at Surface:	Average Between -140 to 20 Celsius

Possibility of Life on Mars



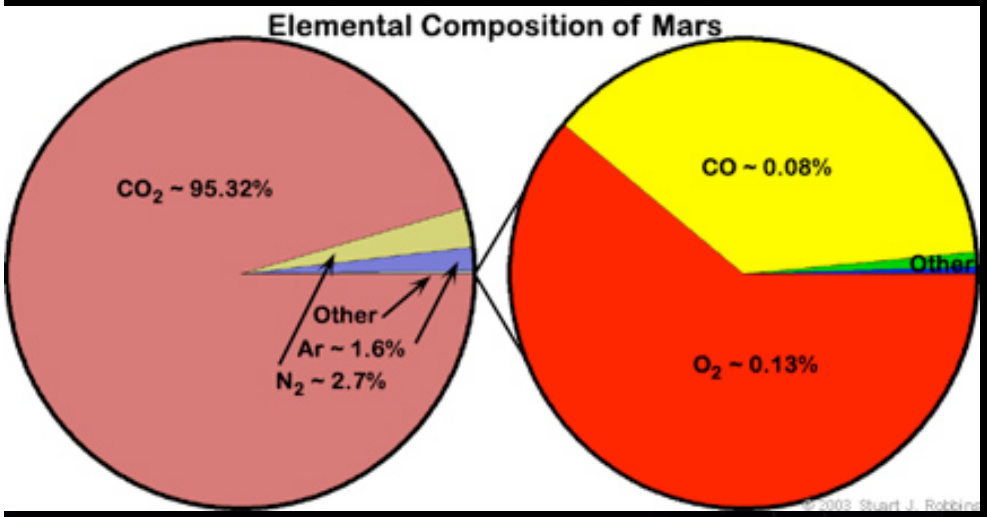
The Rust Planet?

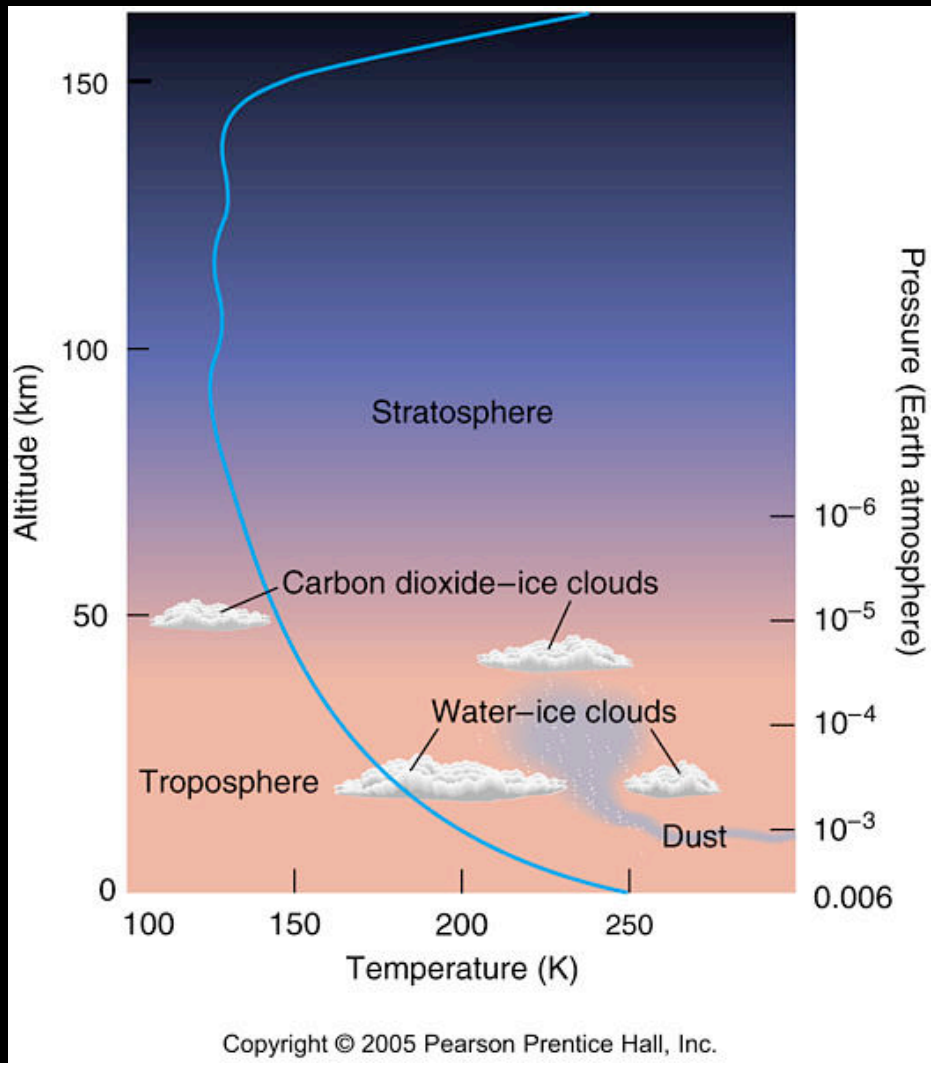
- Yes, redness is iron oxide!
- Composition is same as Earth, but...
- ...early Earth was hotter, so iron was molten and seeped into core
- On Mars, more iron at surface, which rusted

So, not a sign of blood and war!

Possibility of Life on Mars

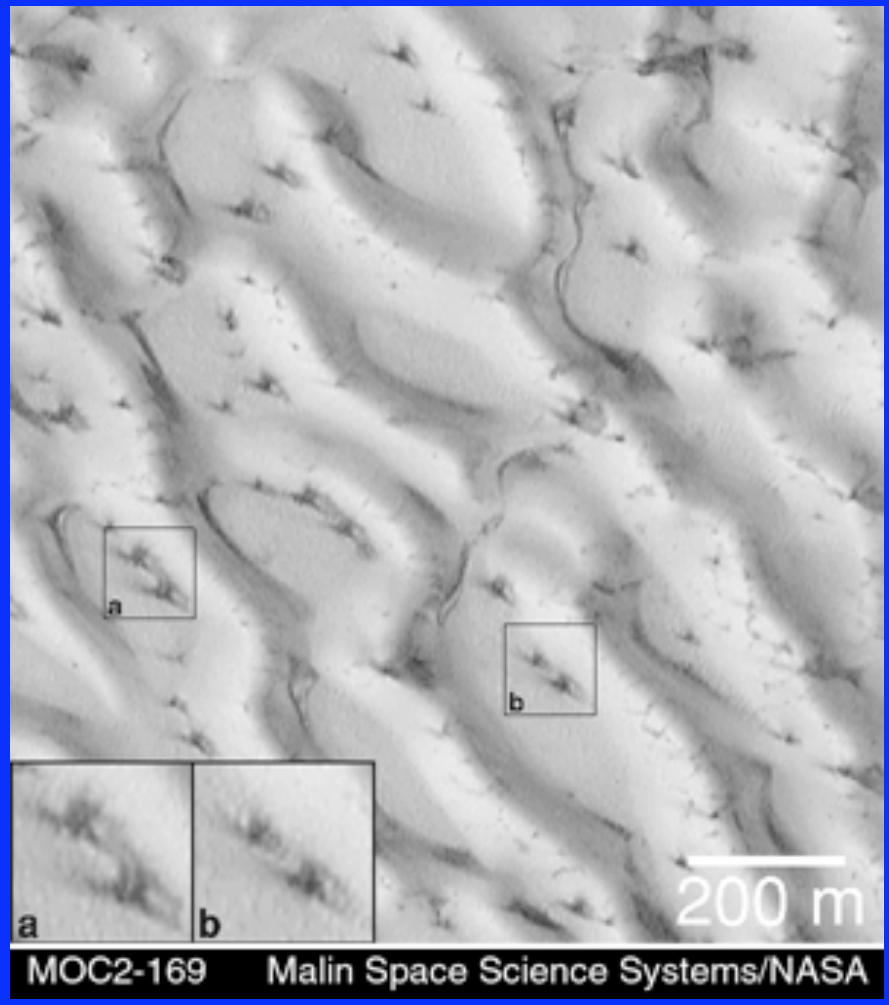
Martian atmosphere – about 1% of Earth





Wind on Mars

- Main process shaping surface today
- Can have planet-wide storms
- Tenuous atmosphere
- Normal speed 17 km/h but can get up to 180 km/h



Possibility of Life on Mars

Martian surface temperature:

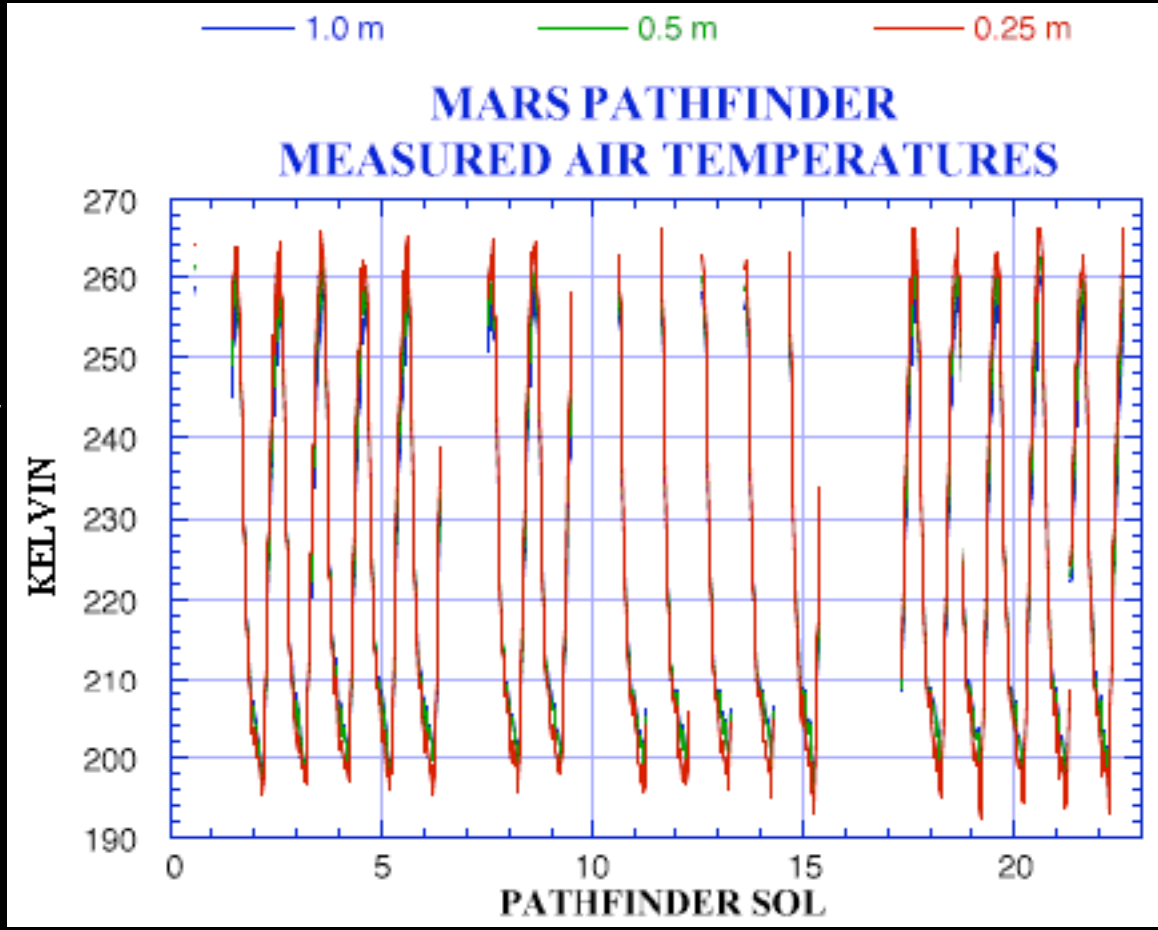
Average temperature: 210 K = -63 C

Typical highs: 260 K

Typical lows: 195 K

Highest measured: +5 C

Soil temperature
high: +27 C



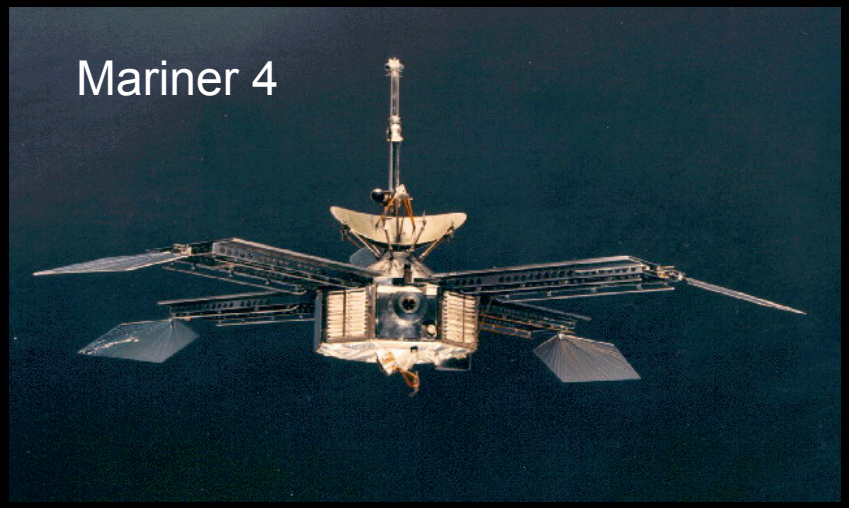
Prospects of Life on Mars?

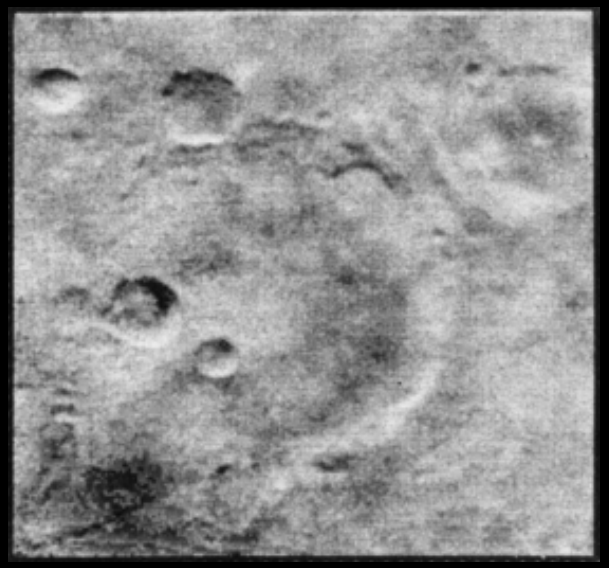
- Few believed Lowell
- But science fiction and popular interest continued, and is maintained to this day
- Still a very popular location for movies of ancient civilizations

Possibility of Life on Mars

History of exploration:

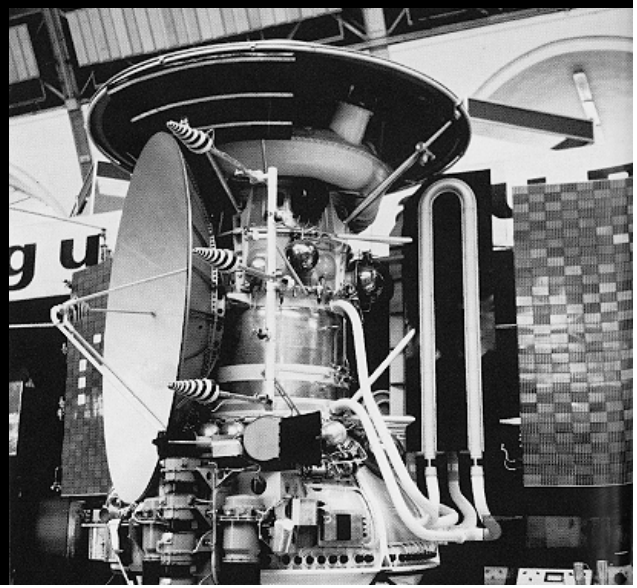
US: Mariner 4 flyby in 1964





Mars image from Mariner 4

Russia: Mars 2 and 3 landed on surface
in 1971
lost contact within seconds

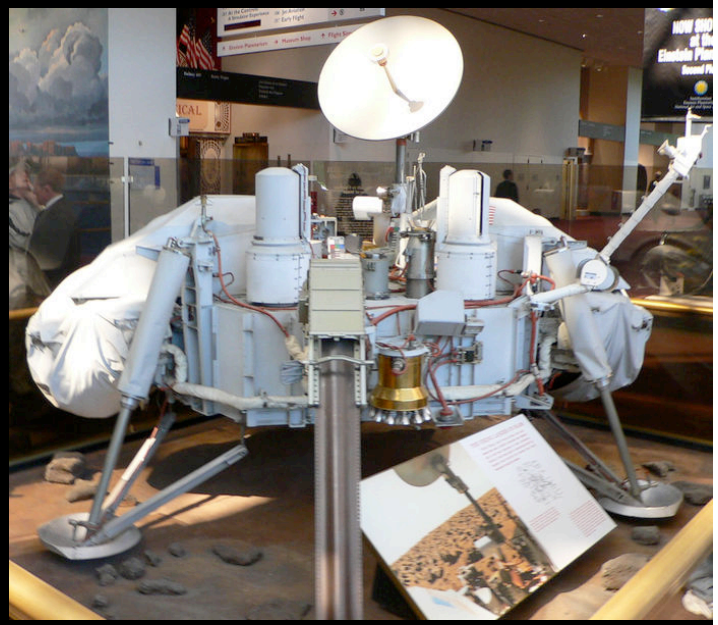


Mars 2

Possibility of Life on Mars

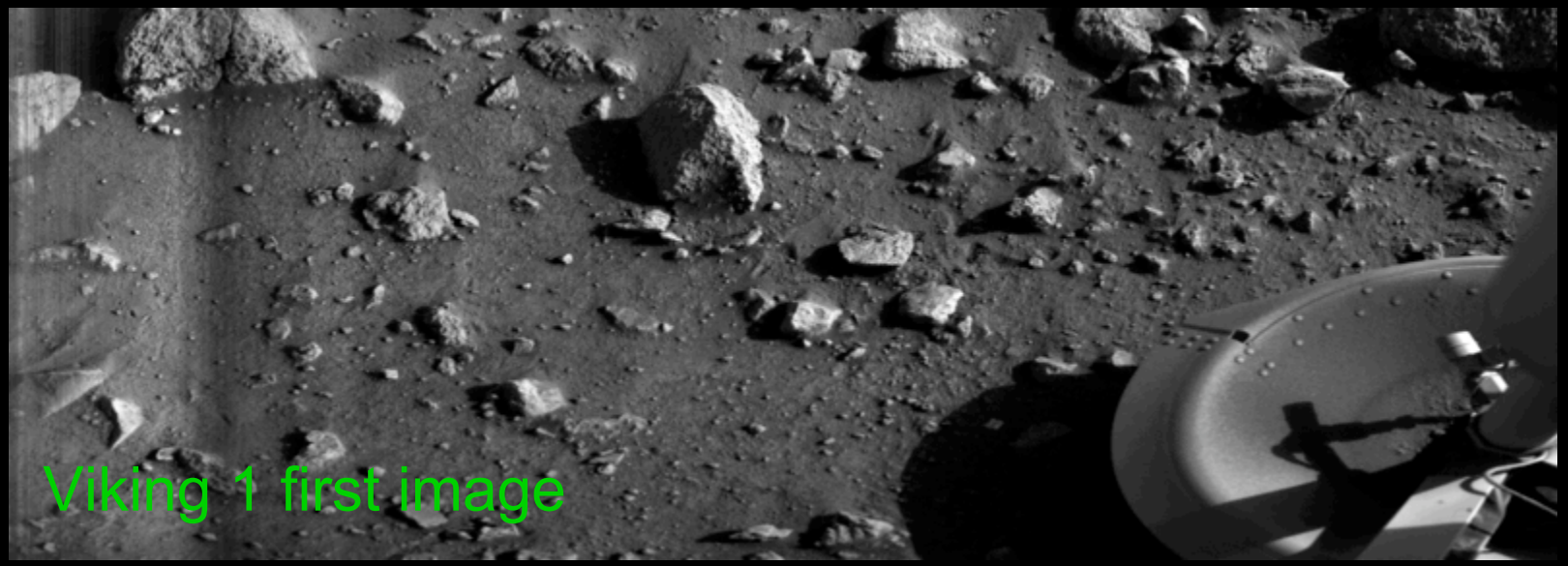
History of exploration:

US: Viking 1 and 2 in 1976
Composed of orbiter and lander
Operated until 1982 and 1980



Possibility of Life on Mars

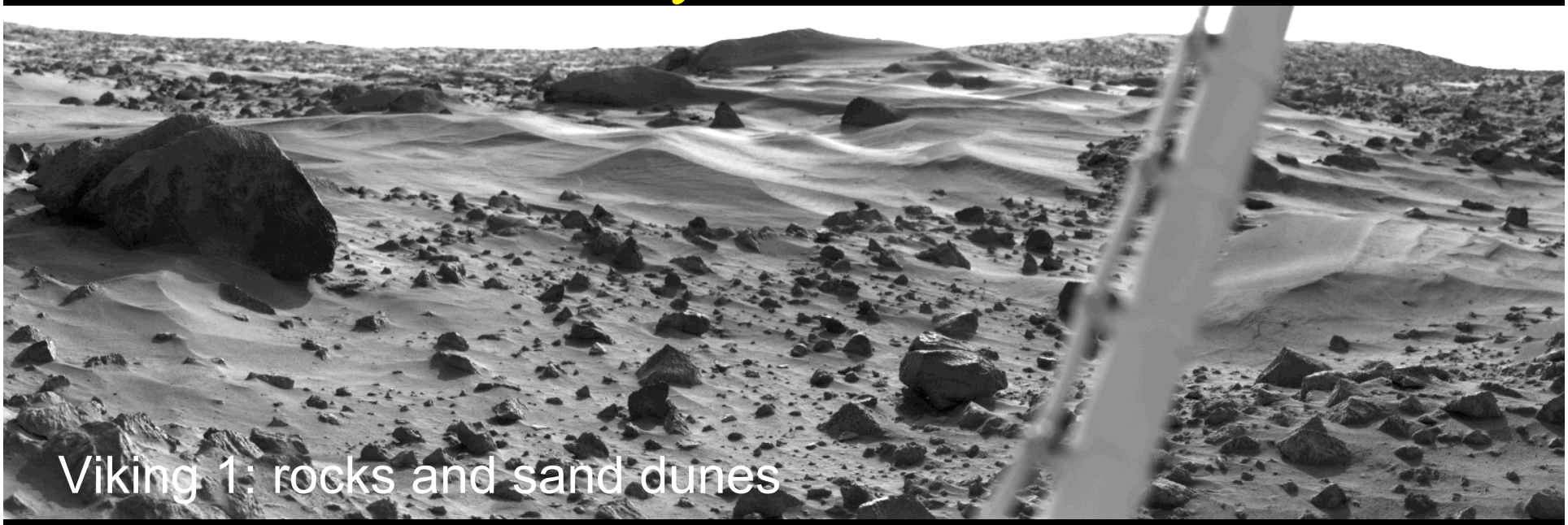
US: Viking 1 and 2 in 1976



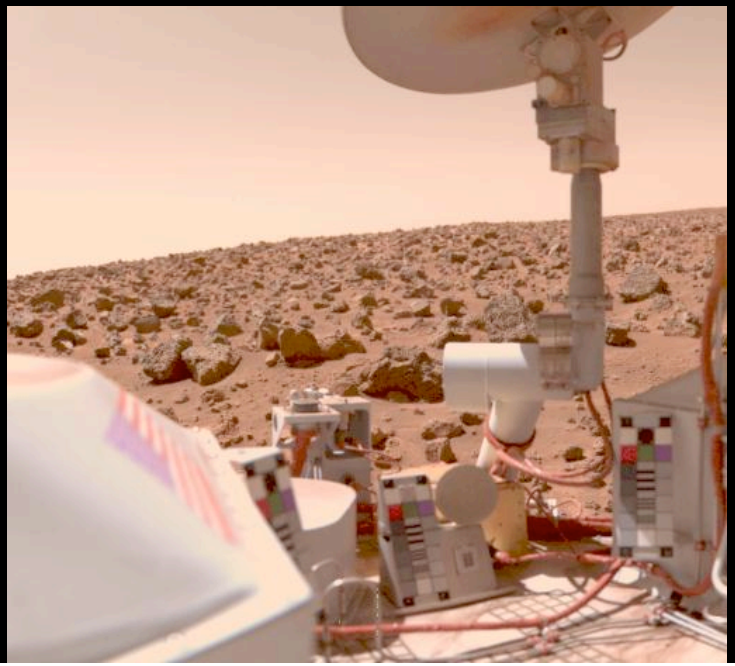
Viking 1 first image

Viking 2

Possibility of Life on Mars

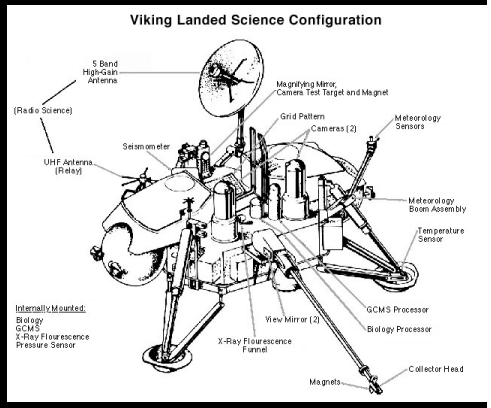


Viking 1: rocks and sand dunes



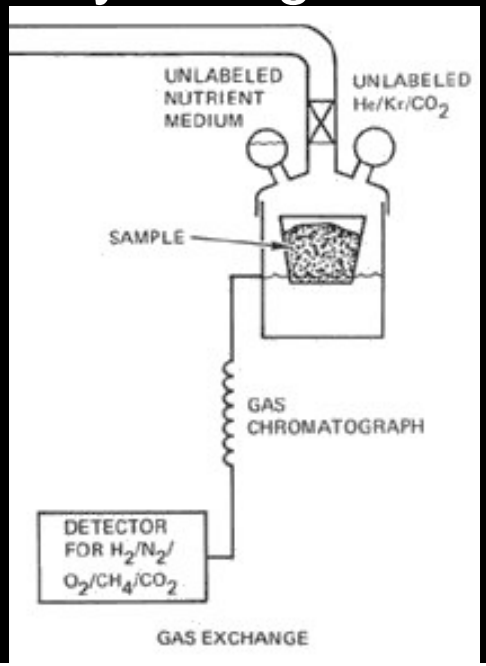
Possibility of Life on Mars

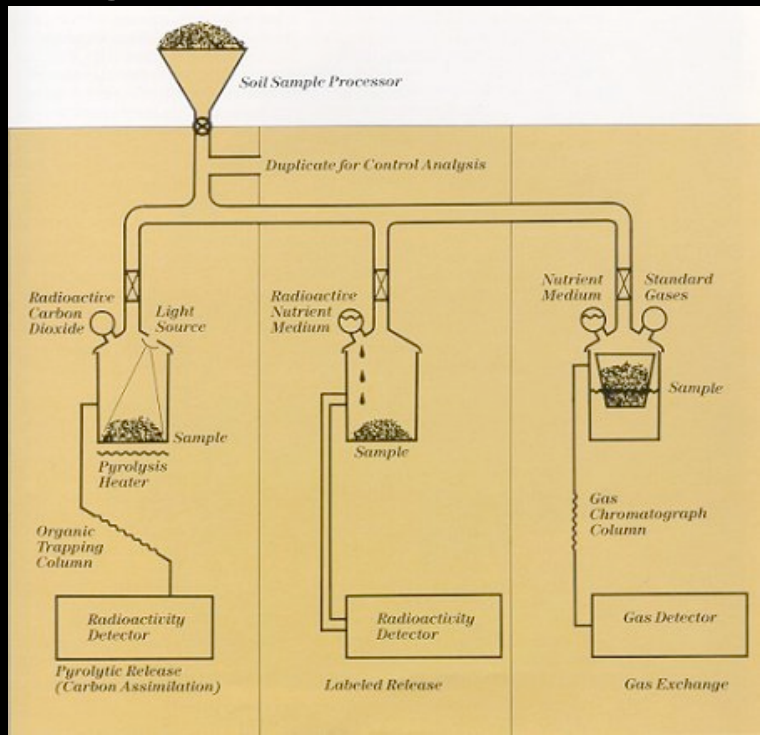
Viking 1 and 2 had four biological experiments.



Gas Chromatograph and Mass Spectrometer
-- searched for organic molecules in soil

Gas Exchange
-- incubate soil sample to search for gases created by biological activity





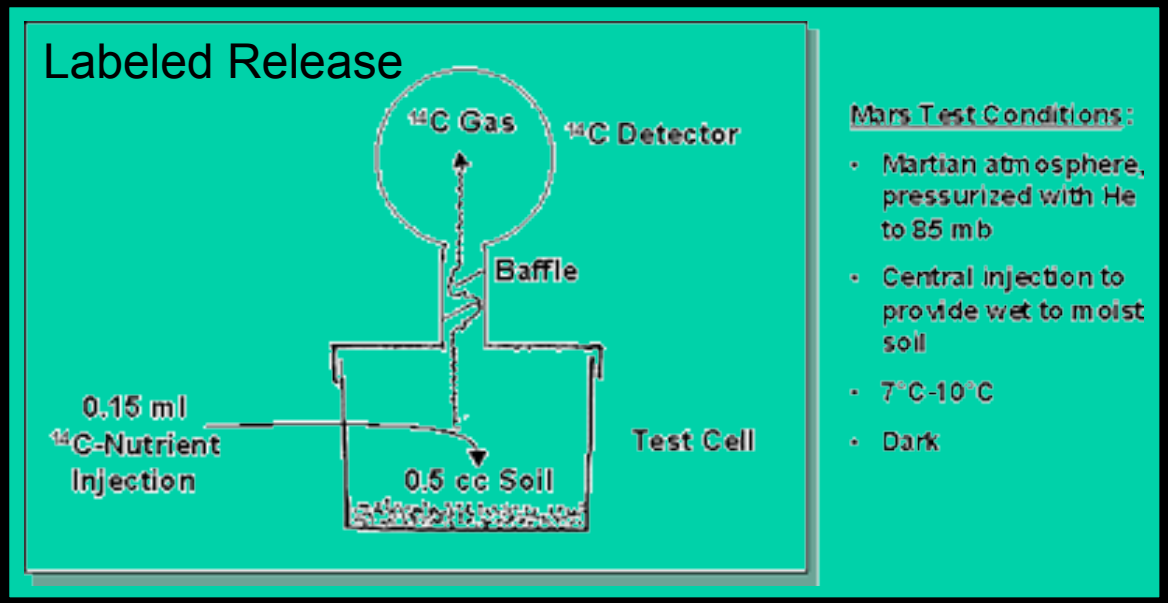
Possibility of Life on Mars

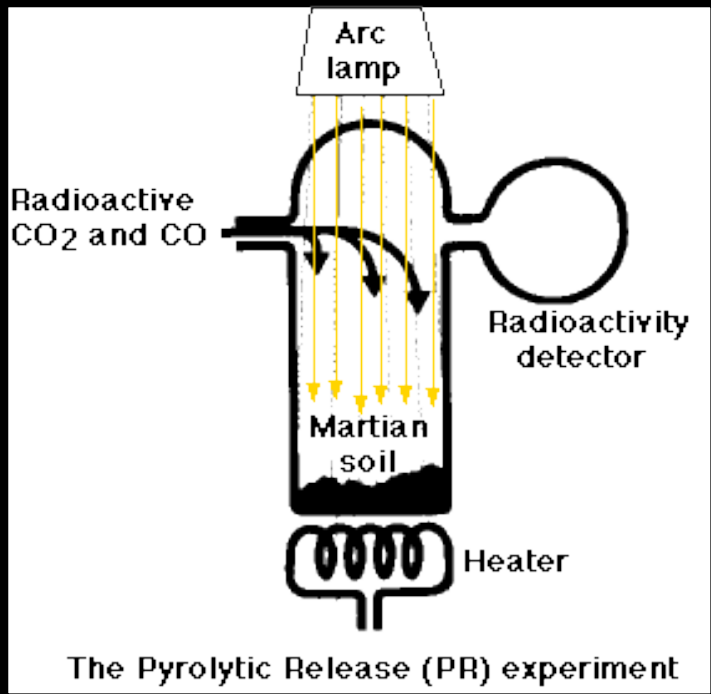
Labeled Release

-- "fertilized" soil with ^{14}C labeled nutrients
then looked for ^{14}C in released gases

Pyrolytic Release

-- exposed soil to CO and CO_2 with ^{14}C labeling, let sit
for several days, then checked soil for ^{14}C componds





Possibility of Life on Mars

Results:

Gas Chromatograph and Mass Spectrometer
-- no organic compounds in soil

Gas Exchange
-- no oxygen, CO_2, methane released – no bio-activity

Labeled Release
-- positive release of ^{14}C containing gases – possible bio-activity

Pyrolytic Release
-- no ^{14}C biomass built-up

Possibility of Life on Mars

Viking Biological Experiment Results:

Most experts now agree that life was not detected by any of the experiments.

It is thought that the Labeled Release experiment detected chemical reactions with soil – main evidence is that the activity started high and decreased with time.

No conclusive evidence for life now active on Mars
No evidence of residual organic molecules
(in these two spots ----
within a few inches of the surface)

Possibility of Life on Mars

Russia: Phobos 1 and 2 to study moons of Mars (1988)

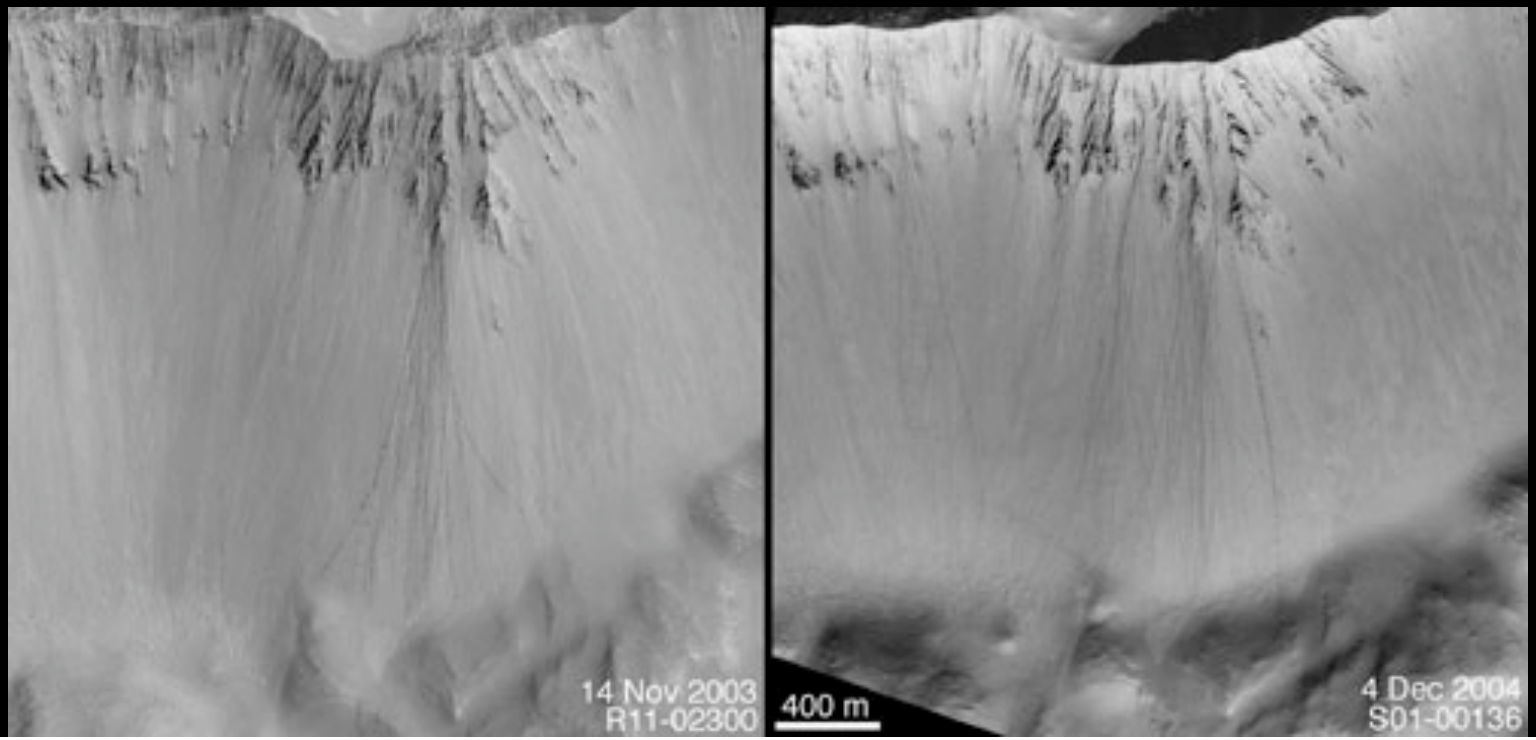
-- Phobos 1 failed

-- Phobos 2 took pictures but lander failed

US: Mars Global Surveyor (1996)

-- operated for 10 years taking pictures of Mars from orbit

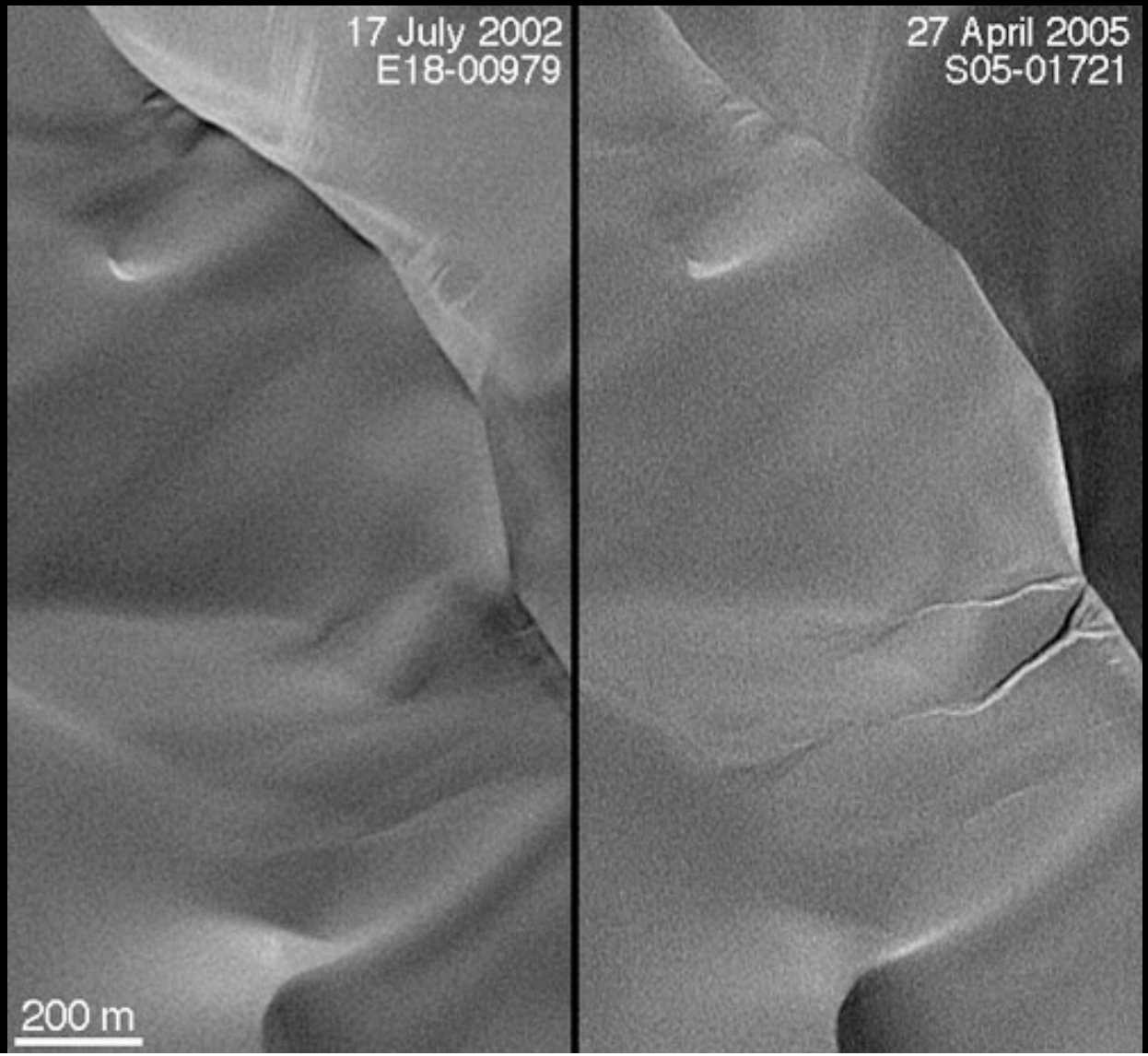
-- 1.6 to 39 ft per pixel, depending on orbital position



Possibility of Life on Mars

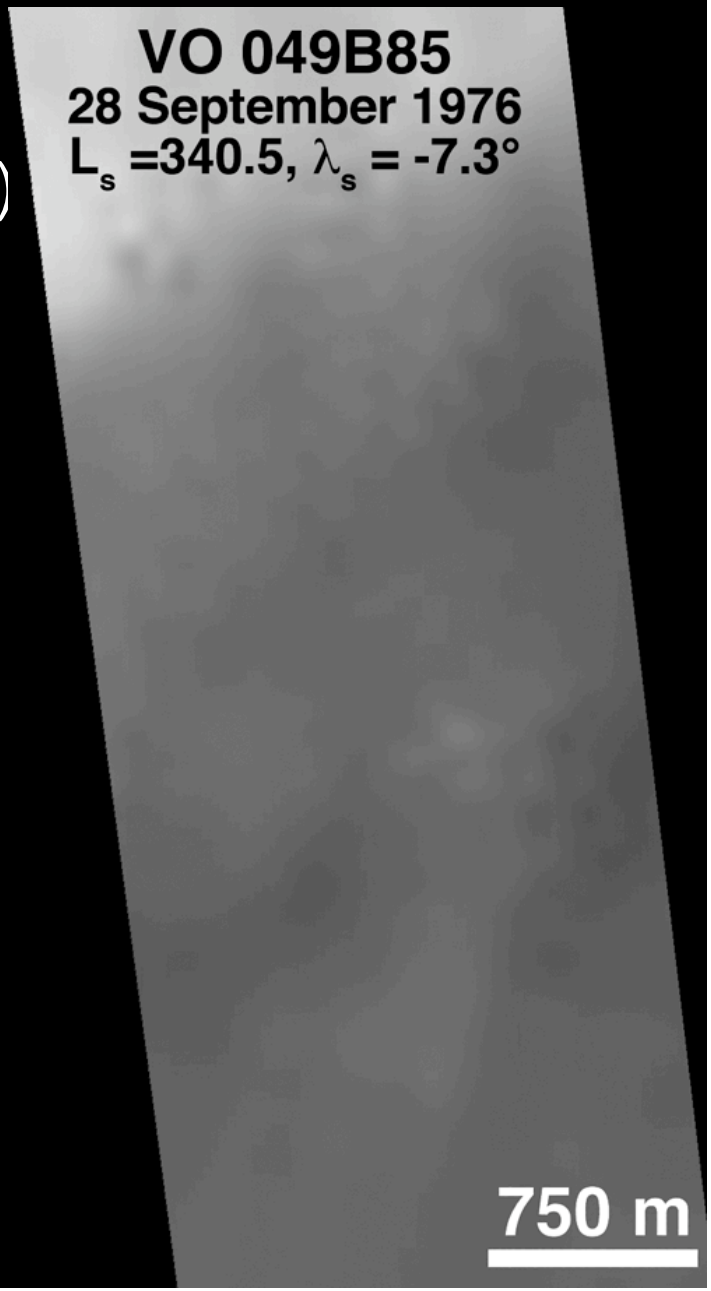
US: Mars Global Surveyor (1996 - 2006)

-- see new surface features formed



Possibility of Life on Mars

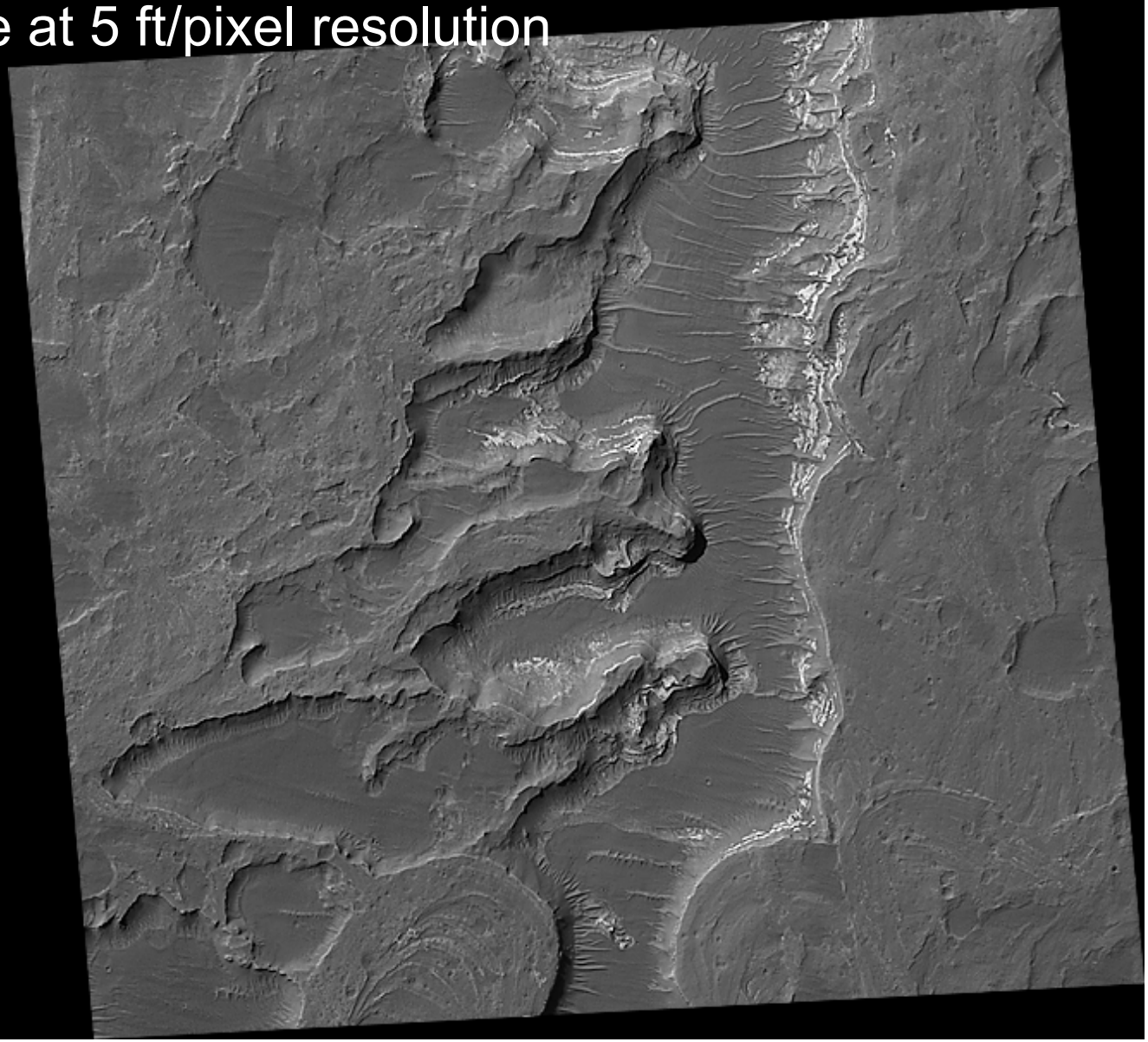
US: Mars Global Surveyor (1996 – 2006)
-- crater forms and fades as
eject become weathered.



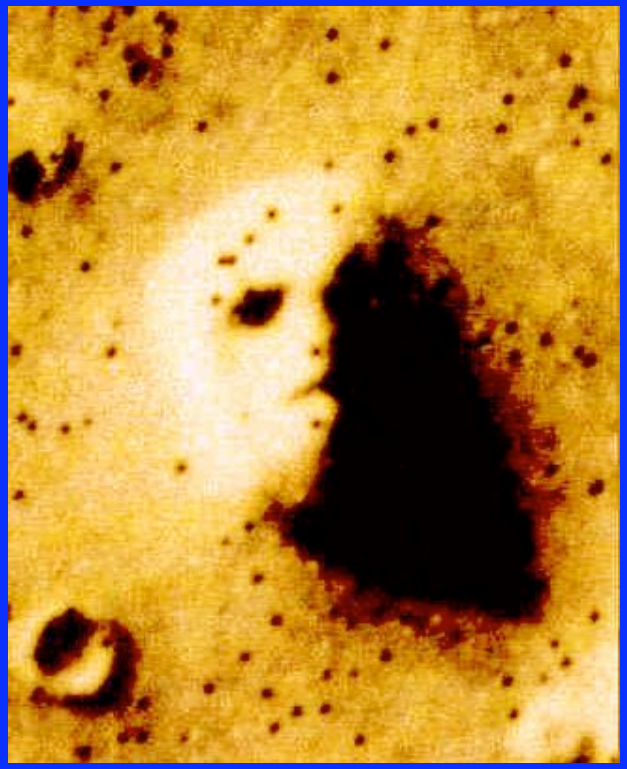
Possibility of Life on Mars

US: Mars Global Surveyor (1996 - 2006)

-- Delta feature at 5 ft/pixel resolution



Face on Mars? No!



Possibility of Life on Mars

US: Mars Pathfinder – Sojourner (1997)

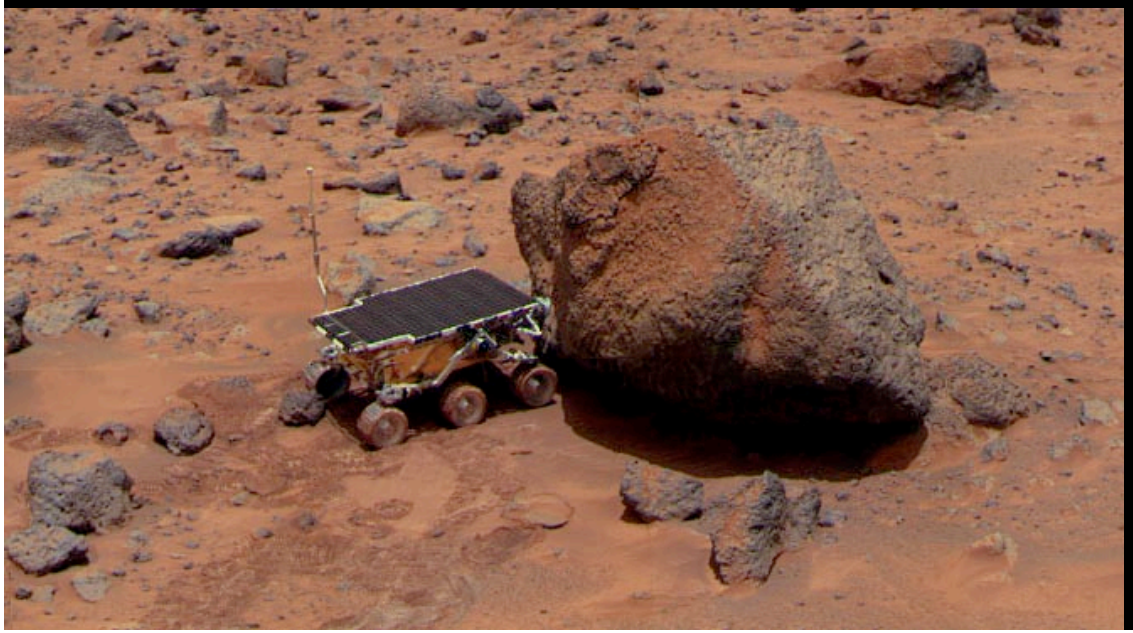
-- in contact for 83 days

-- images

-- analysis of rock – high silicon content volcanic rocks

-- one rock appeared to be deposited by a flood

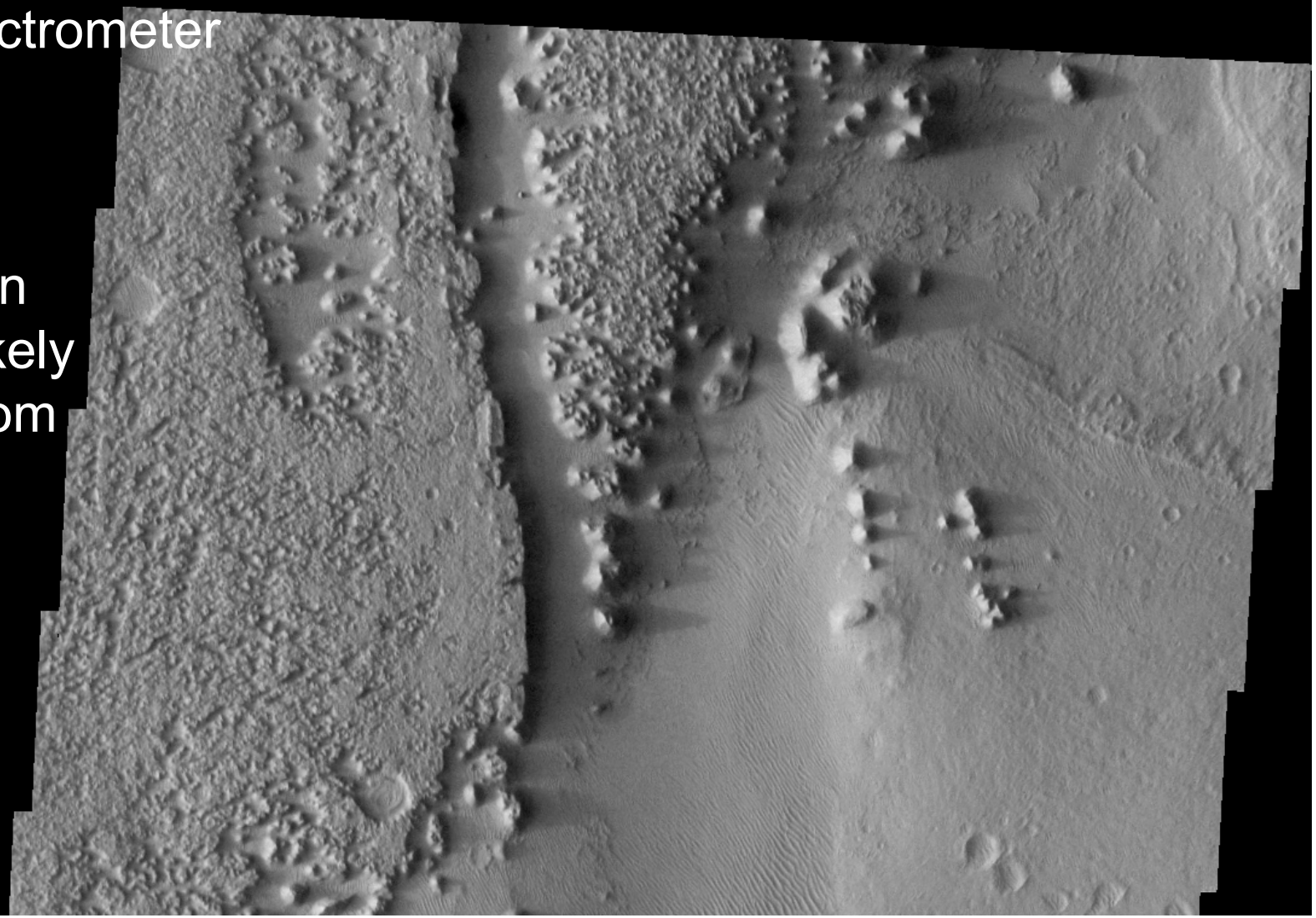
-- one rock showed clear wind weathering



Possibility of Life on Mars

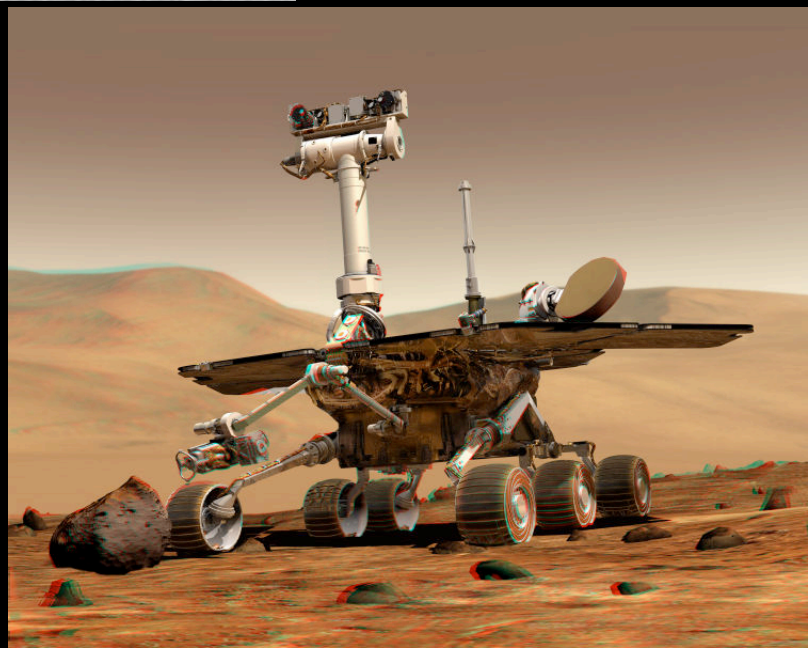
US: Mars Odyssey (2001 – present)
orbiting optical and thermal imager and Gamma ray spectrometer

Found hydrogen which likely came from water



Possibility of Life on Mars

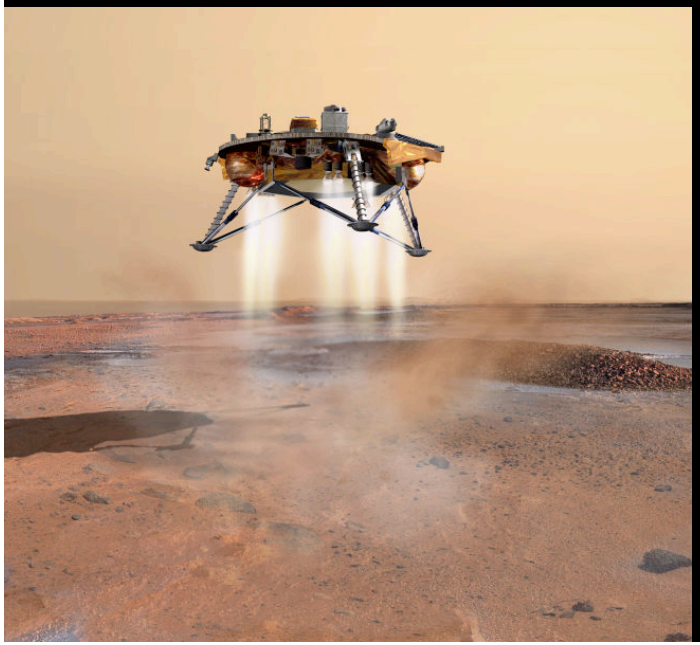
US: Mars Rovers – Spirit and Opportunity (2003 – present)

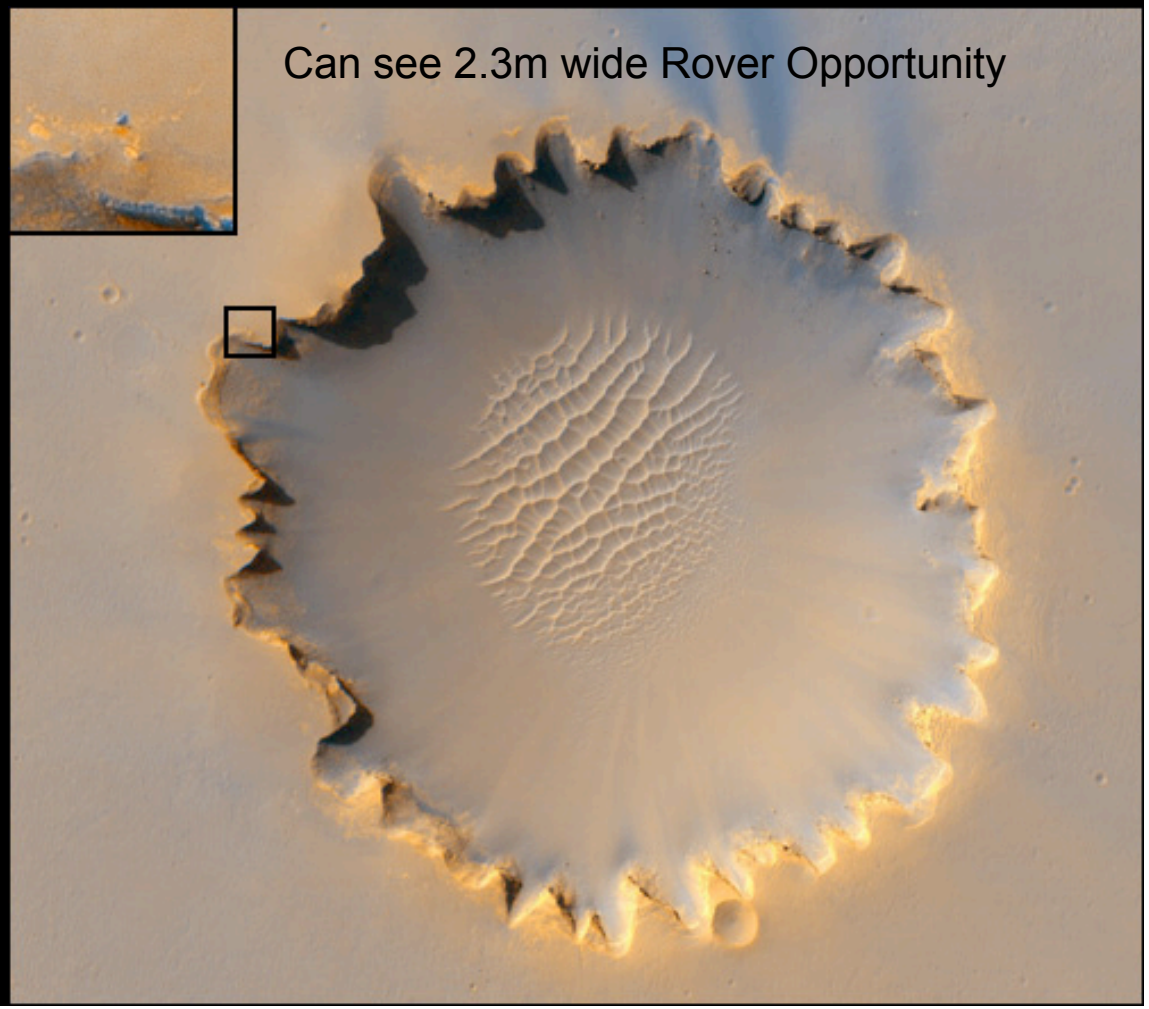


Possibility of Life on Mars

US: Mars Reconnaissance Orbiter (2006 – present)
-- further detailed imaging of planet in preparation for a lander exploring the polar cap

US: Phoenix landed at polar region, analyzed ice -- May 2008

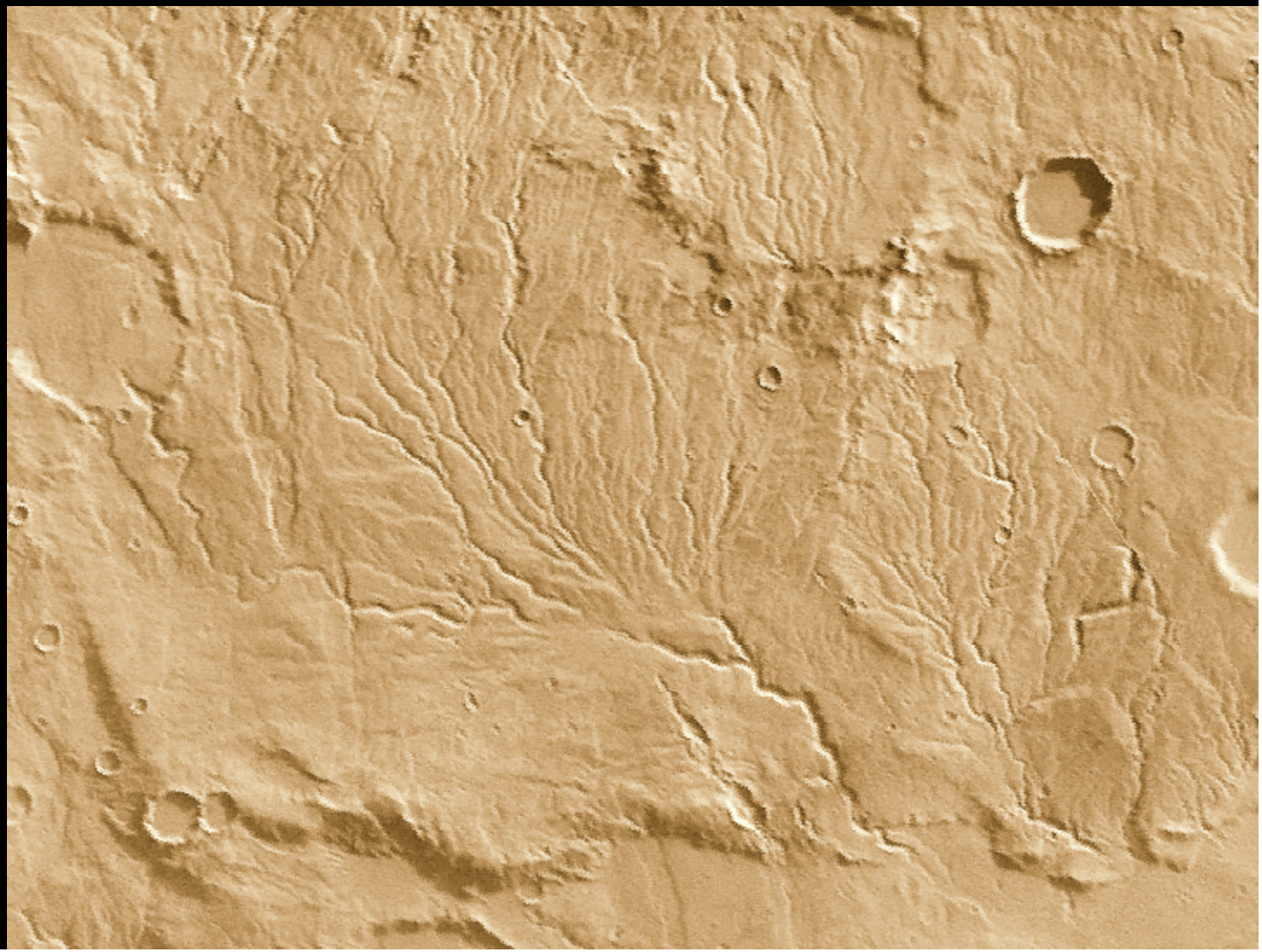




Possibility of Life on Mars

What is the evidence that there was once water on the surface of Mars?

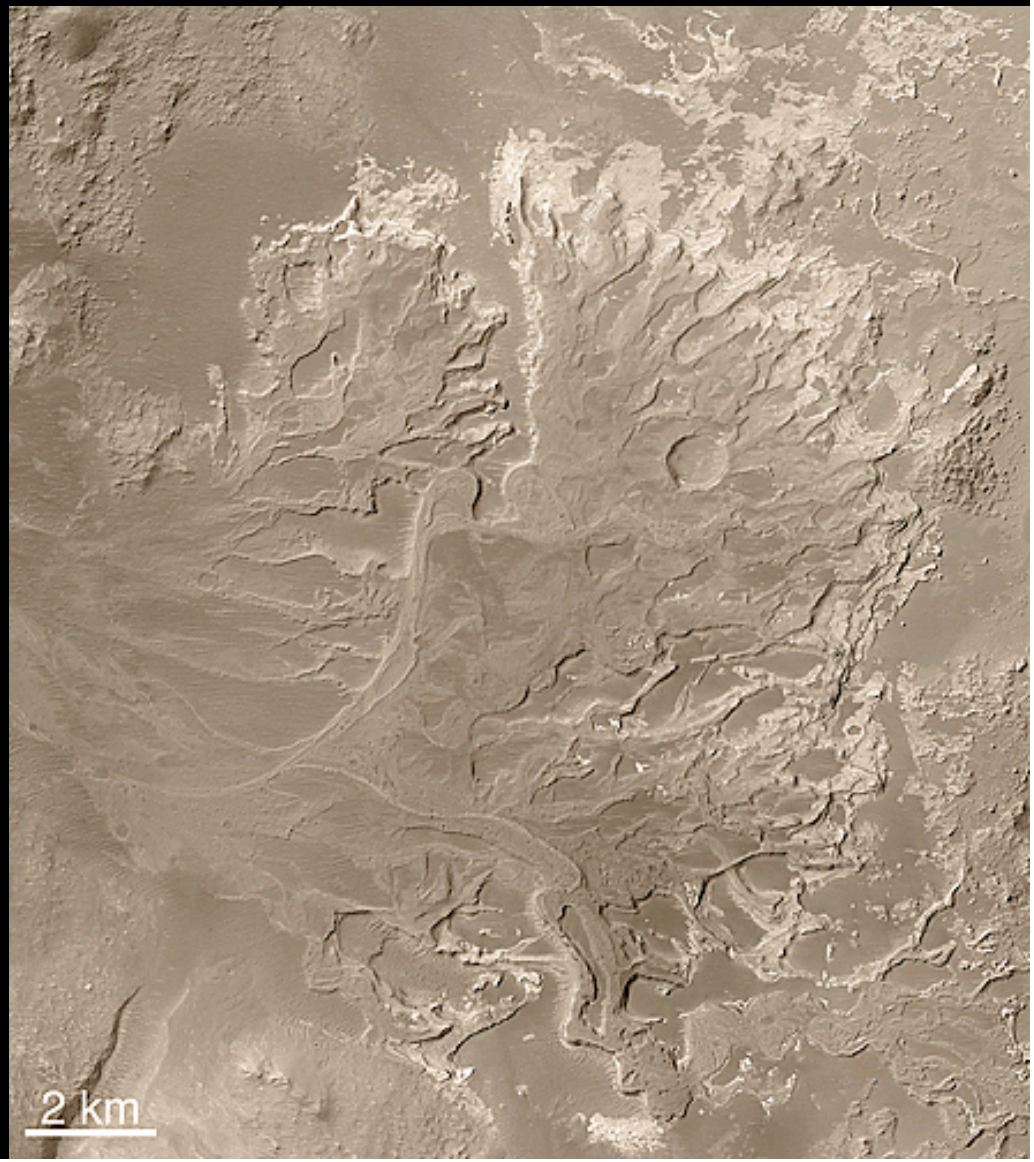
River-like flow networks



Possibility of Life on Mars

What is the evidence that there was once water on the surface of Mars?

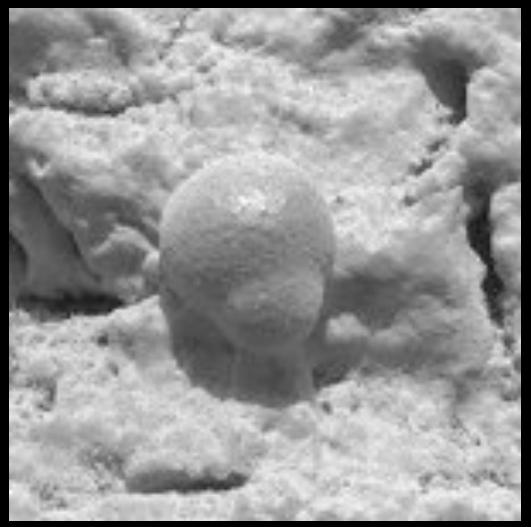
Regions that look like river deltas and dried lakebeds



Possibility of Life on Mars

What is the evidence that there was once liquid water on the surface of Mars?

Rocks with minerals and microscopic features that likely required water to form.

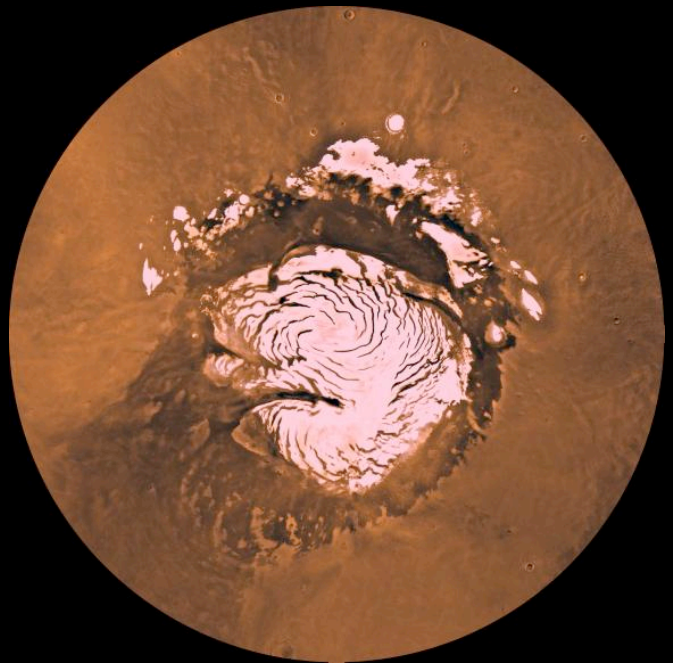


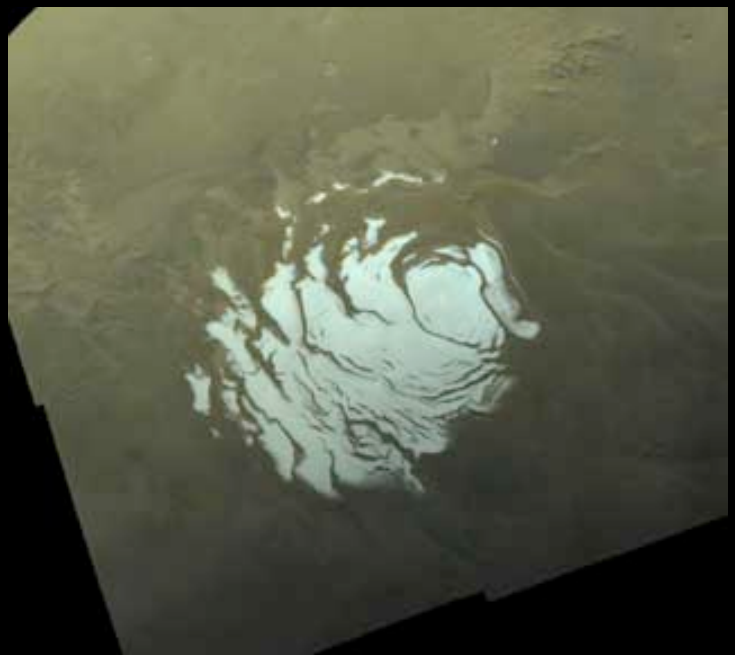
Possibility of Life on Mars

What is the evidence that there was once liquid water on the surface of Mars?

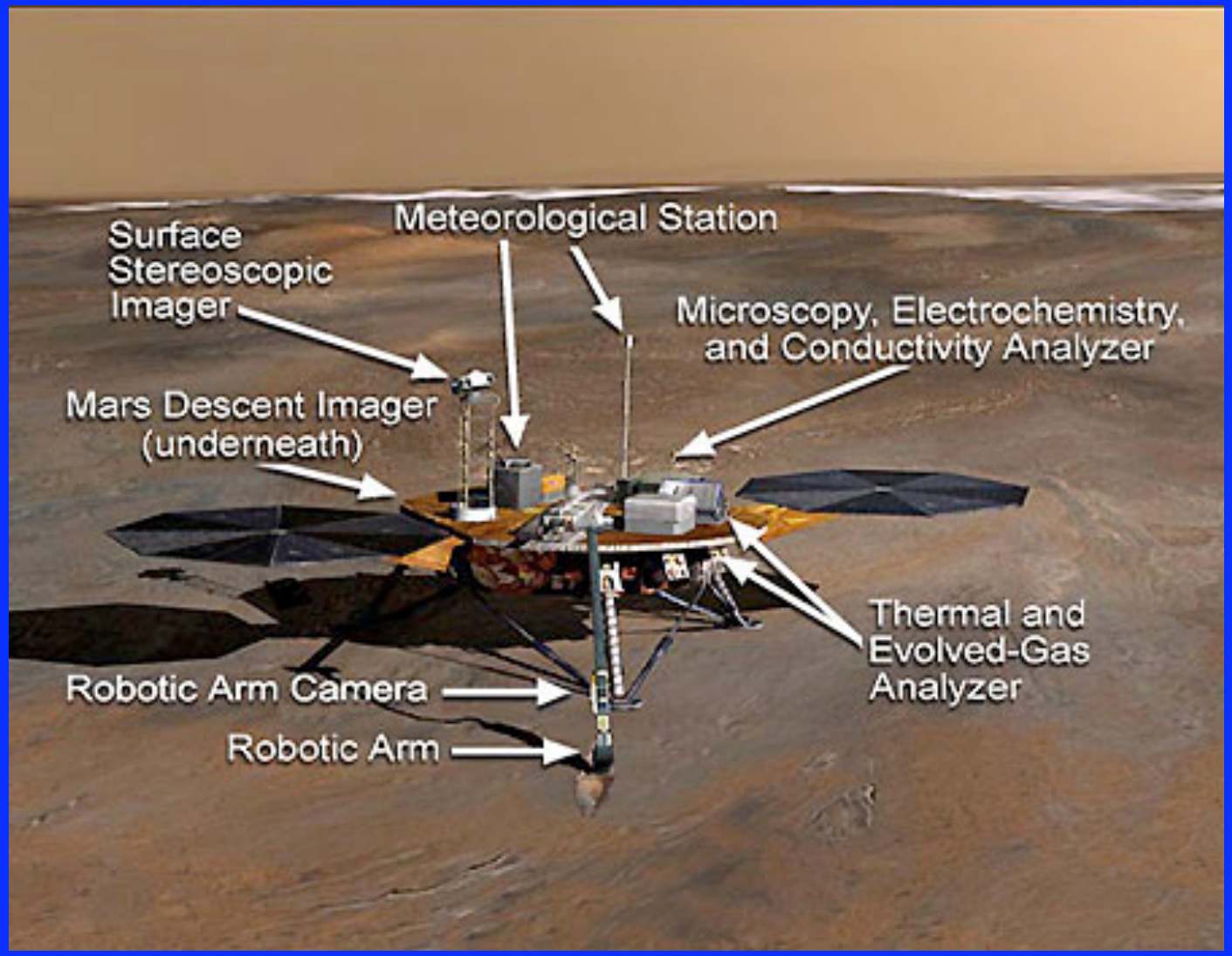
The current polar ice caps are known to contain water ice based on several types of orbital measurements.

By one estimate, the southern ice cap has enough water to cover the entire planet to a depth of 11 meters!!!





Mars Phoenix Lander



http://pal2pal.com/BLOGEE/images/uploads/phoenix_lander_labels.jpg

Info from Phoenix

- Water ice definitely detected under surface
- Even more interesting: soil has mineral nutrients needed for some Earth plants
- But no life detected yet

Possibility of Life on Mars

What is the evidence for current or past life on Mars?

Viking life-detection experiments showed no evidence for currently active life and no evidence for complex organic compounds at two sites – disappointing!

Extensive imaging with around 1 meter resolution finds no evidence for life anywhere on planet.

Any life, current or past would have to be at the cell level.

Possibility of Life on Mars

What is the evidence for current or past life on Mars?

Best argument for past life is the ALH84001 meteorite.

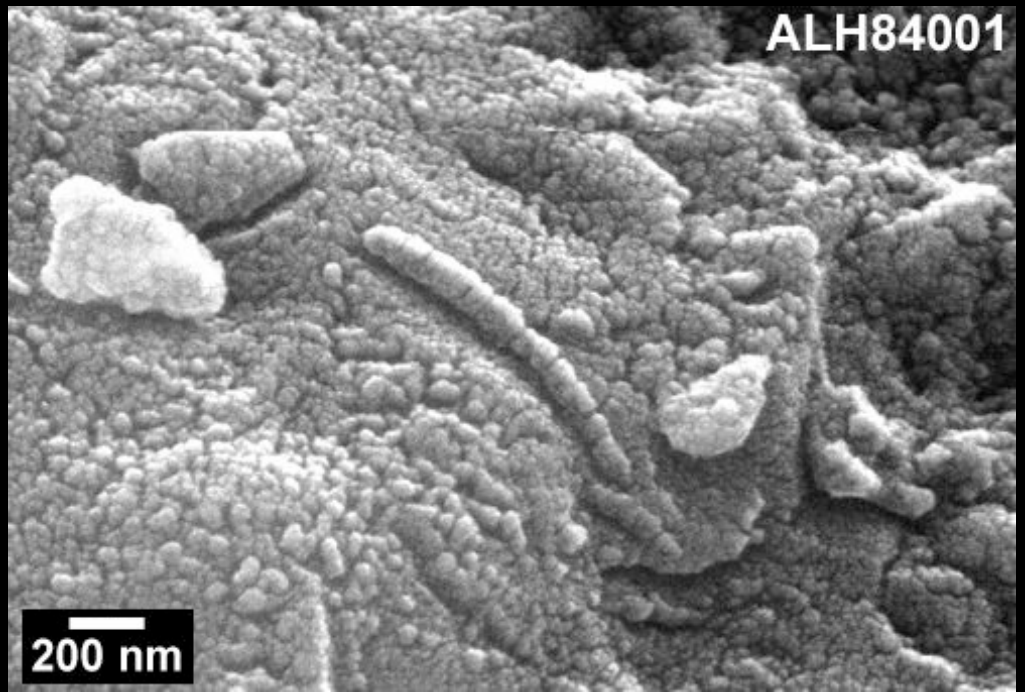
-- 4.5 Billion years old rock
-- detached from Mars 15 Million years ago in an impact
-- landed on Earth 13,000 years ago and found in 1984

Possibility of Life on Mars

Best argument for life to date is the ALH84001 meteorite.

-- microscopic analysis of structures in the meteorite found linear structures which were claimed to be fossil bacteria.

-- Most scientists in the field now agree that these are probably geological formations, not fossil life.



Possibility of Life in the Inner Solar System

Mars versus our checklist:

chemical building blocks: Earth-like origin. Lots of C, N, O.

energy: reasonable sunlight. Temperature on the cold side.

liquid: Not at the present – but water ice. Strong evidence for liquid water in the distant past.

stability: currently stable but not at the best conditions

Best possibilities for current life are at the ice caps or underground. Reasonable chance of life in the past, depending on how long water lasted!

NASA/JPL/Malin Space Sciences System

Debate: Current Life on Mars?

- Is there currently life on Mars?
- First point of view: yes, even if it is only microbial, life exists now on Mars
- Second point of view: no, no life currently, although life might have existed in past

Summary

- Surface life is likely absent on Mars at this time
- Recent liquid water implies (1) life might have existed at earlier times, and (2) subsurface life might exist there now
- Many missions are being sent there; maybe we'll discover something cool!