

# Lecture 27: Is There Life on Mars?

## Lecture 27 Is There Life on Mars?

Astronomy 141 – Winter 2012

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This lecture is about the search for life on Mars

The idea of a habitable Mars springs from telescopic observations in the 18<sup>th</sup> and 19<sup>th</sup> centuries, and persisted well into the 20<sup>th</sup> century.

First space probes disproved the idea of Martian canals, and showed Mars was a dry, cold desert world.

The Viking Landers found no conclusive evidence of life.

Martian meteorite ALH84001 shows controversial evidence of possible past biological activity.

Future Mars missions are being designed to search closely for evidence of life.

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The idea of intelligent life on Mars is common in popular culture.



War of the Worlds  
1898



1917



1948



1950



1961



2012

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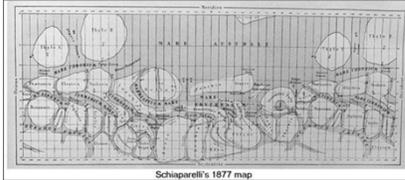
# Lecture 27: Is There Life on Mars?

Giovanni Schiaparelli (1835-1910) made extensive observations of Mars, and gave its features their names.

Director of Milan Observatory

In 1877 claimed to see linear features he called "*canal*" (channels)

Thought of them as natural features.



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Percival Lowell (1855-1916) took Schiaparelli's "canals" seriously and reported further observations.

Selected a site near Flagstaff, Arizona, where he built a private observatory.

High altitude and clear calm skies.



Spent 2 decades observing and mapping the surface of Mars.

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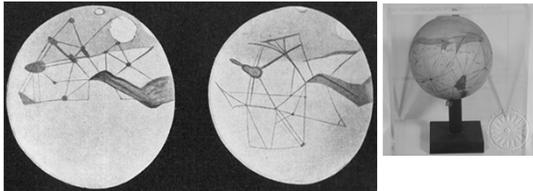
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Lowell published maps of what he thought were extensive purpose-built canal systems on Mars.



Popularized the idea of Mars as inhabited with intelligent beings.

Wrote and spoke extensively on the subject until his death.



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# Lecture 27: Is There Life on Mars?

The first spacecraft to visit Mars showed it to be a dry, cold desert planet with no canals...



Mariner 4  
(Flyby 1965)



Mariner 9  
(Orbiter 1971-72)



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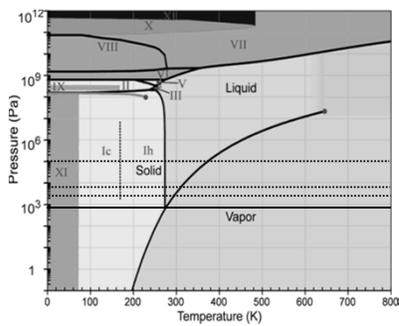
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Measurements of the atmosphere from spacecraft showed it was too thin to have stable liquid water.



Liquid water is *unstable* on Mars – solid or vapor only.

1 Atm (Earth)  
Pre-spacecraft  
Mariner 6/7 (1969)

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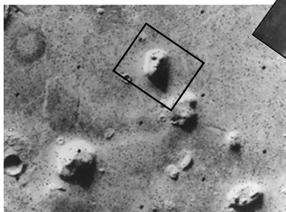
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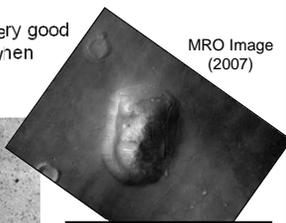
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What were the canals? Optical illusions.

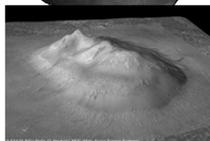
The human visual system is very good at picking out patterns, even when they are not there.



Mars "Face" from Viking 1 Orbiter (1976)



MRO Image  
(2007)



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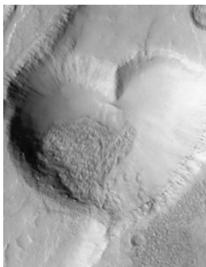
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# Lecture 27: Is There Life on Mars?

Sometimes, the mind sees what it wants to see in a picture...



Galle Crater (Smiley Face)  
[MOC 2003]



Mars Heart  
[MOC 1999]

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The Viking 1 & 2 landers were designed specifically to search for signs of life on Mars

Landed in 1976

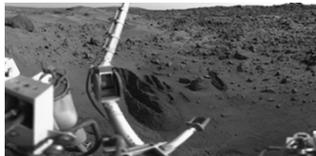
4 Experiments onboard:

Carbon assimilation

Gas exchange

Labeled release

Mass spectrograph (to detect organic compounds)



First three searched for evidence of uptake and metabolization of Carbon when soil samples were heated or wetted with nutrient water solutions.

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The results from the Viking Landers are conflicting. Many questions are still unresolved...

Carbon assimilation and Gas Exchange gave positives, but could be explained by the presence of Iron Peroxide or other strong oxidants in the soil.

The Labeled Release experiment gave a burst of oxygen when the sample was wetted, but no response to nutrients.

The spectrograph found no organic molecules to very low levels (10 million times lower than Earth).

The labeled release results are still disputed...



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# Lecture 27: Is There Life on Mars?

ALH84001 is a meteorite found in Antarctica that is an ancient rock from Mars

1.9 kg meteorite found in the Allan Hills region of Antarctica (ALH) in 1984.

Contains Martian gases, and is radioactive dated to 4.5 Gya when Mars was likely wet.

Shows evidence for liquid water and carbonate crystals

Analysis in 1996 suggested it may contain signs of fossil microbial life...



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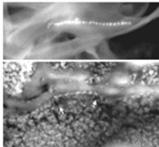
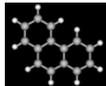
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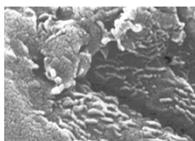
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Evidence for possible biological activity in ALH84001:

Presence of polycyclic aromatic hydrocarbons and amino acids



Magnetite crystals like those produced by Earth bacteria.



Shapes resembling terrestrial nanobacteria, but much smaller than any seen on Earth.

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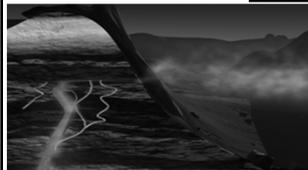
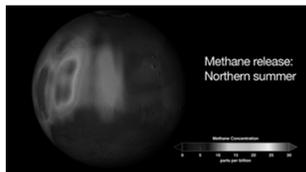
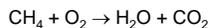
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In 2004, Methane (CH<sub>4</sub>) was detected in Mars' atmosphere using ground-based telescopes.

Methane can only last ~300 years Mars



Sources of methane:  
Comets  
Volcanoes  
Biological processes (methanogenic bacteria)

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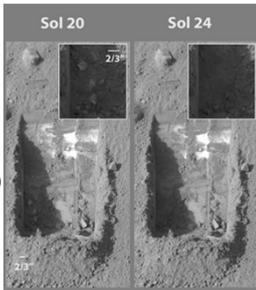
In 2008 the Mars Phoenix Lander found water ice and perchlorate salts near Mars' north pole.

Dug into the soil and found subsurface water ice.

Saw water snow falling from cirrus clouds.

Found Calcium Carbonate in the soil ( $\text{CO}_2$  reacting with liquid  $\text{H}_2\text{O}$ )

Found Perchlorate Salts ( $\text{xClO}_4$ ) a strong oxidant that lowers the freezing point of water, affecting soil and atmosphere humidity.



Sublimating water ice on Mars

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Future missions to Mars are planned to carry out extensive biochemical searches

Mars Science Laboratory Mission (Launched Dec 2011)



Will land in a site that has evidence of past water flows.

Detailed study of the Mars climate and geology.

Experiments:

- Inventory of elements, especially organic compounds
- Biological experiments (carbon uptake, metabolism, etc.)
- Detailed surface mineralogy

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