

# Earthlike Planets

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Earth and  
Venus



Earth and  
Mars

# Outline

## Overview

## Venus

Exploration

Surface

Geology

Atmosphere

## Mars

History

Exploration

Surface

Geology

Geography

Atmosphere

# Overview



Venus

Just slightly smaller than Earth.

Surface is completely obscured by clouds.

Rotation time is 243 days – retrograde!

Year is 225 days, combine that with the retrograde rotation and Venus' day is 117 Earth days.



Mars

One half of the Earth's diameter.

Surface is easily visible in small telescopes.

Day is slightly longer than Earth's and axis tilt is about 25 degrees.

# Venus Exploration

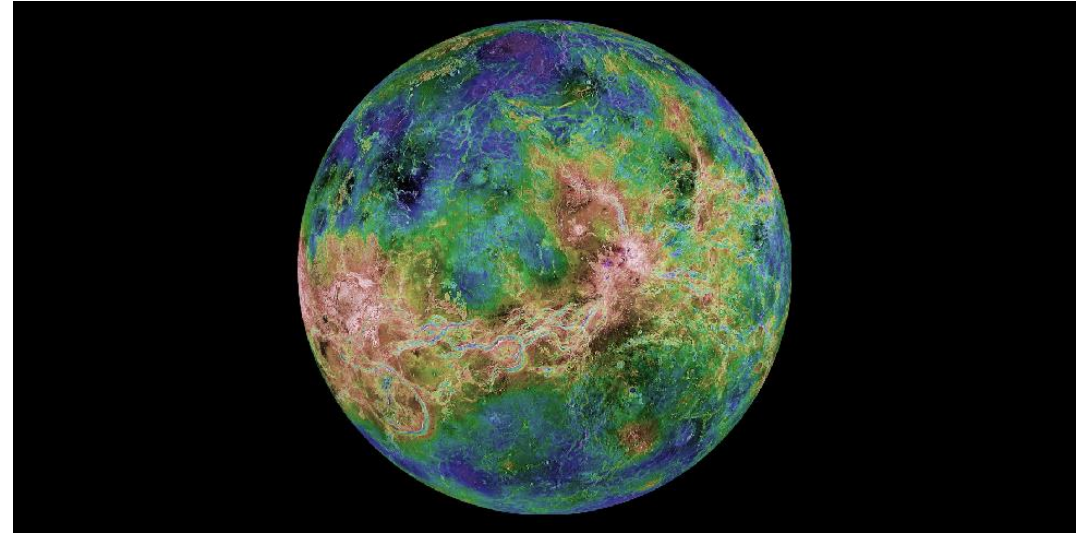
Early missions

Pioneer Orbiter

Venera Landers

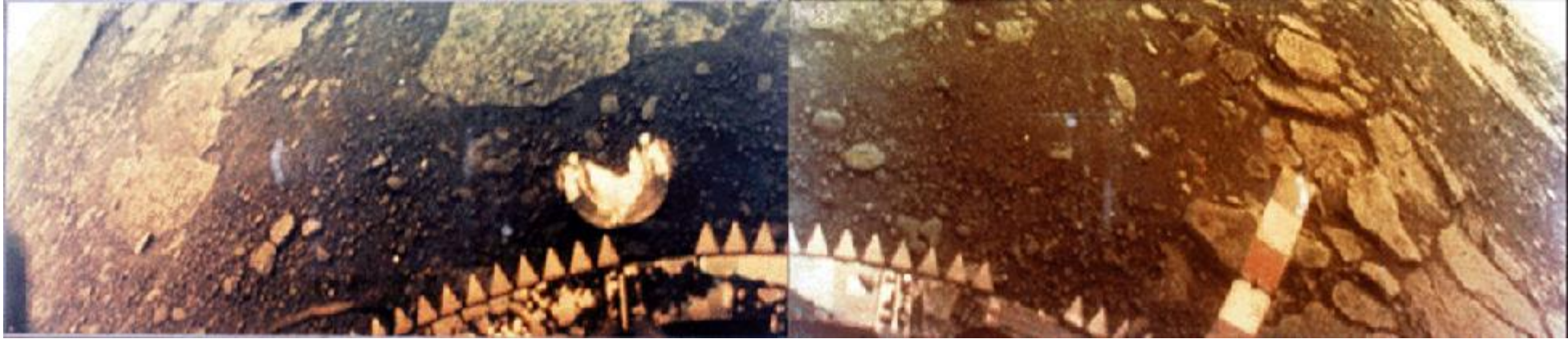
Magellan Orbiter 1990-1994

Venus Express 2006 - 2014



Radar image of Venus

# Venus' Surface



Surface of Venus

## Venera Landers

Igneous (volcanic) rocks, primarily basalts

Layered lava flows

Flat rocks which may be ejected by an impact

Little evidence of erosion

# Venus' Geography

## Two Continents

Aphrodite along the equator

Ishtar in the northern hemisphere

About 80 % of the surface is smooth, volcanic plains

Few impact craters

Evidence of extensive volcanism



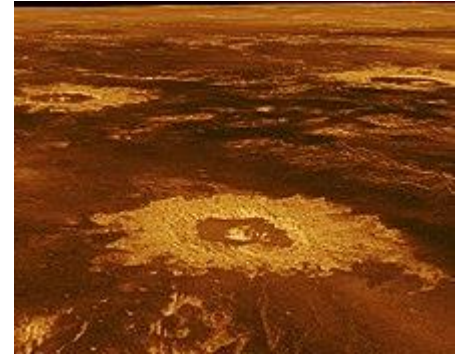
# Venus' Geology

Many volcanoes

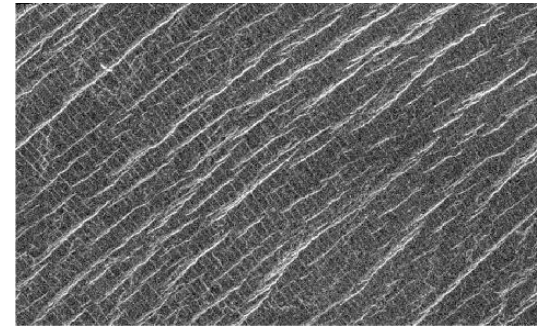
Evidence of cracks and strains in the surface indicating convection of interior material

No evidence of subduction or plate tectonics

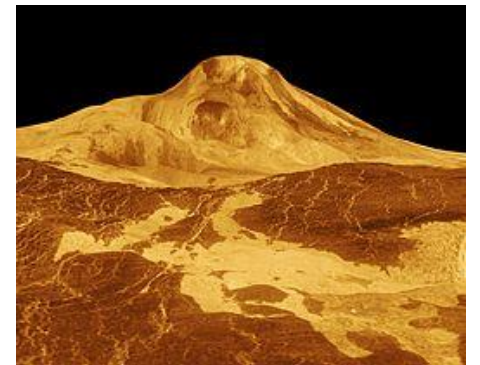
Relatively few impact craters implies a young surface



Impact Craters



Ridges and cracks



Maat Mons

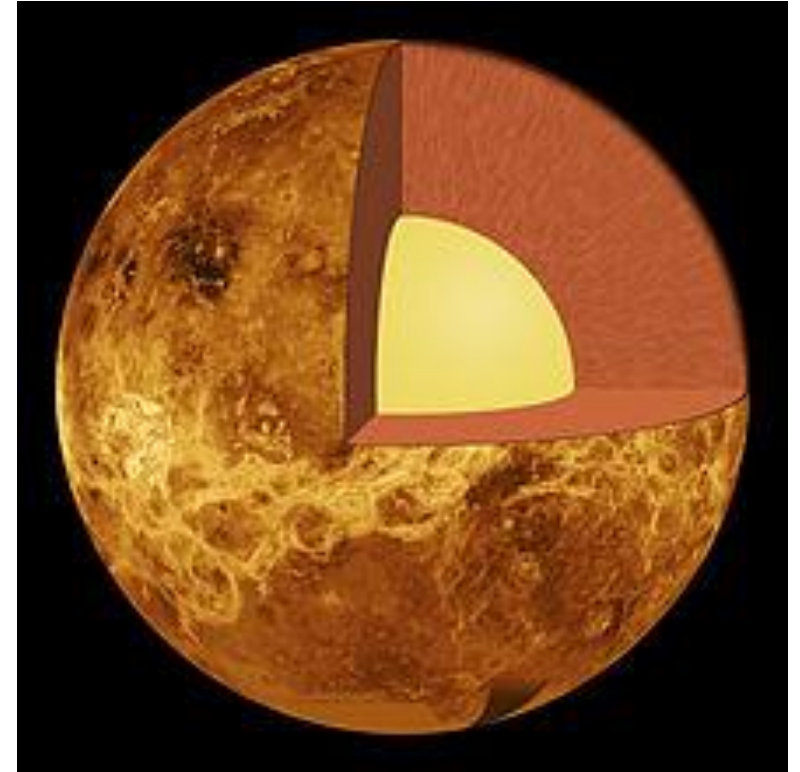
# Venus' Geology

Interior – little is known. Similarity in size and density suggest core, mantle and crust similar to Earth?

However –

No intrinsic magnetic field

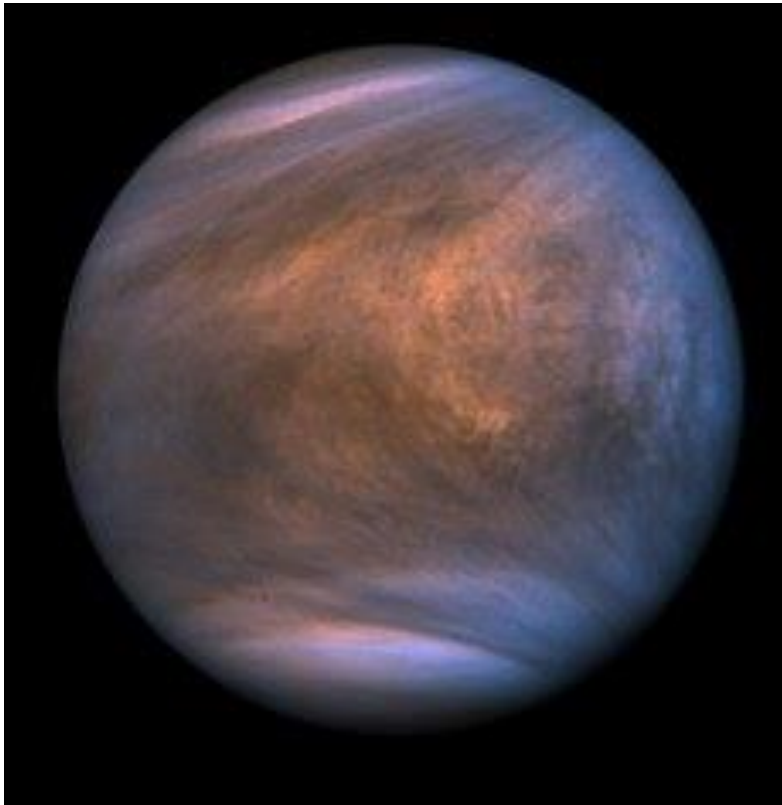
No plate tectonics



Interior of Venus



# Venus' Atmosphere



Venus cloud structure in ultraviolet

96.5 % carbon dioxide

3.5 % nitrogen

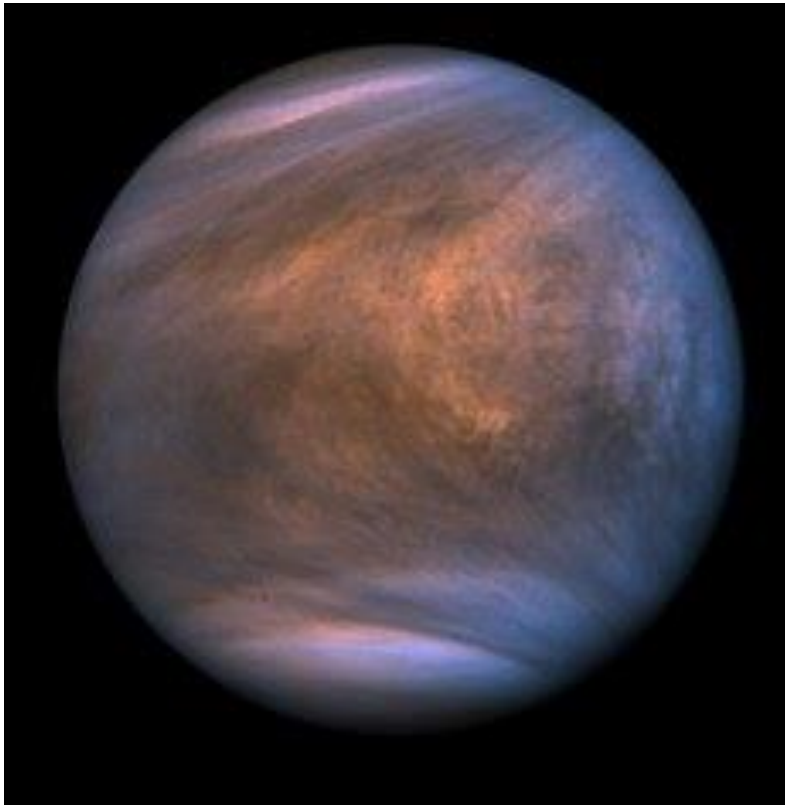
Trace of other gasses including sulfur dioxide

Strong greenhouse effect

Surface temperature of 735 K, hotter than Mercury

Atmospheric pressure 92 times sea level pressure on Earth

# Venus' Atmosphere

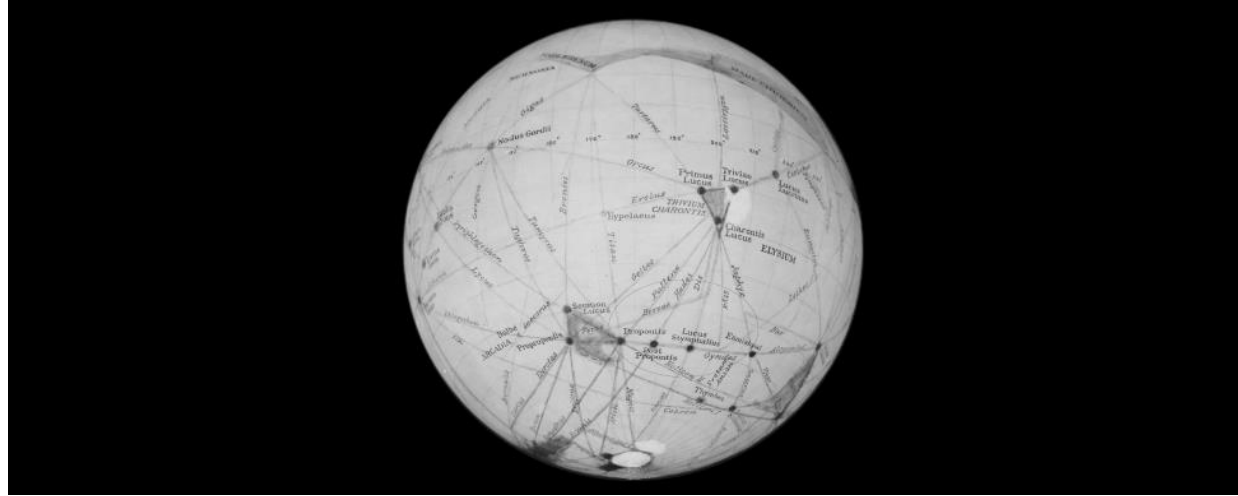


Venus cloud structure in ultraviolet

Phosphine gas was reported in Venus' upper atmosphere in September 2020 in sufficient quantities suggesting that it was created by biological processes.

Most astronomers now believe this detection was in error.

# Mars History



# Lowell drawing of Mars

# Mars is very easy to observe

## Polar caps which expand and contract with the season

Approximately two year orbit

## Similar axis tilt, day, and seasons to Earth

## Seasonal changes to surface

# Mars History

In 1877 an Italian astronomer, Giovanni Schiaparelli claimed to have discovered “canale”, channel in Italian.

Translated to “canals” in English speaking countries.

Controversial among astronomers – couldn’t see canals.

An American amateur, Percival Lowell, became a proponent of intelligent life on Mars.

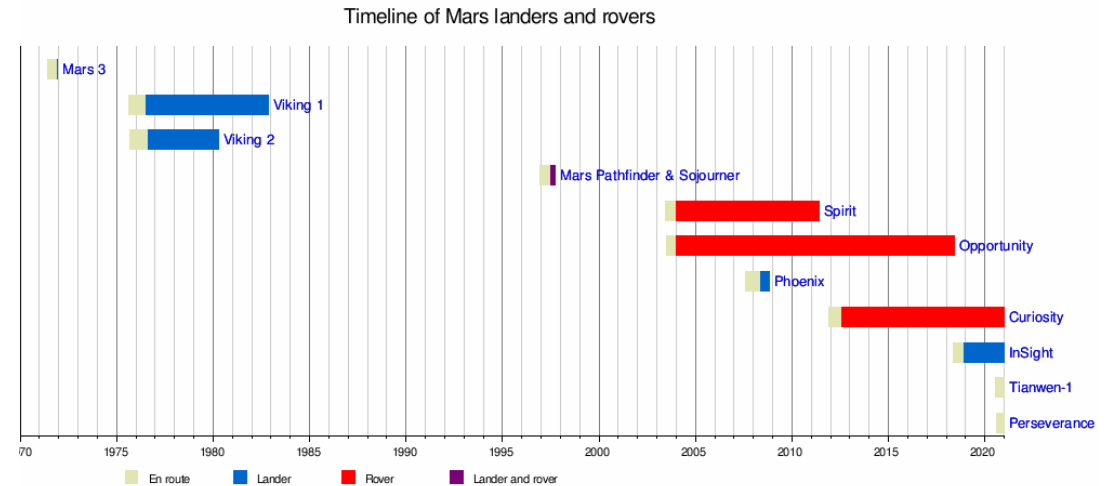
Built Lowell Observatory to continue observations.

# Mars Exploration

49 Missions to Mars to date  
About half failed

10 successful landers, all but  
one from NASA

3 more en route



Mars landers and rovers

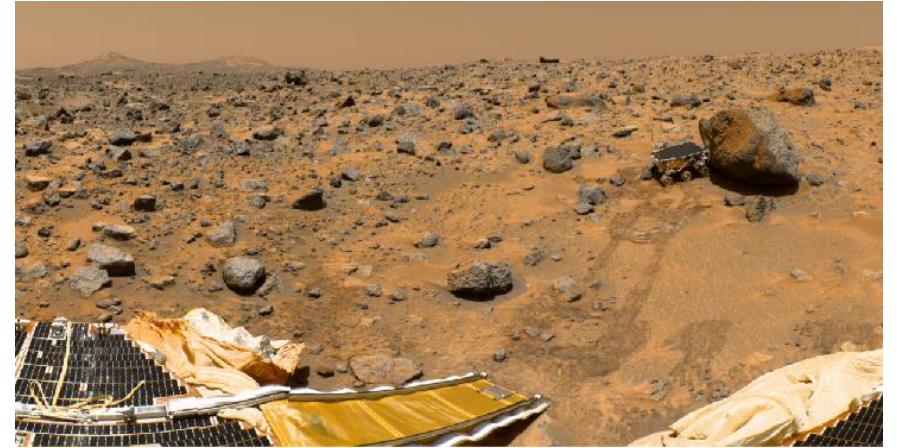
# Mars Surface

Giant volcanoes

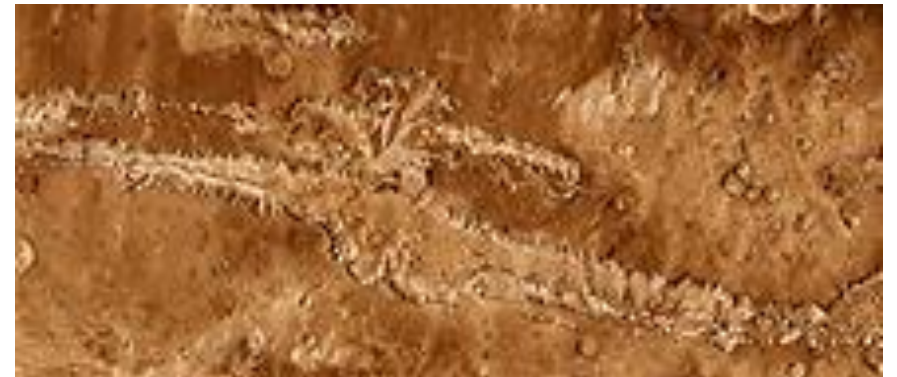
Canyons

Channels cut by running water

Layers of ice in the polar caps



Mars surface from Pathfinder



Valles Marineris



# Mars Surface- evidence of water



(a)

Left – runoff channels



(b)

Right – outflow channels

Runoff channels are what is expected from surface runoff from rain

Outflow channels may be from melting of subsurface ice

# Mars Surface – evidence of water

Seasonal flows on warm slopes  
called Recurring Slope Lineae  
(RSL)

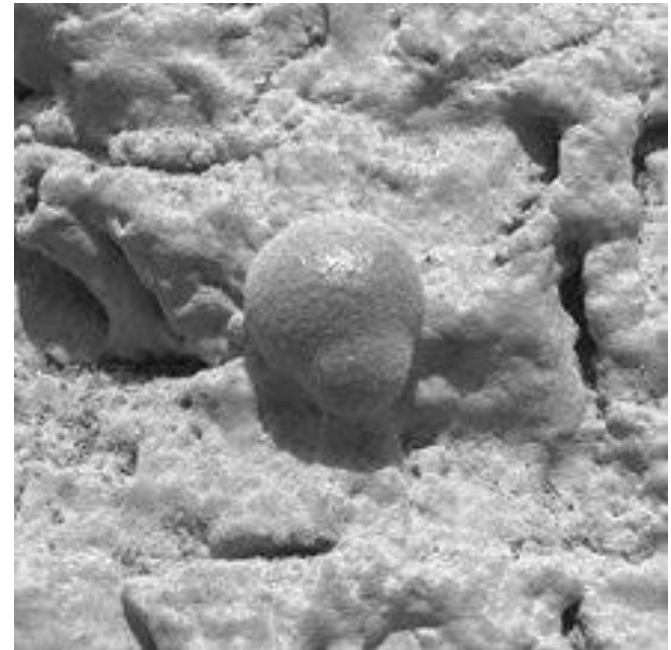
Possibly due to water



RSL on crater wall

# Mars Surface – evidence of water

Hematite – a mineral that forms under water



Hematisite Concretion

# Mars Surface – polar caps

Polar caps consist of a permanent water ice cap and a seasonal dry ice cap



Top: North Polar Cap in Summer  
Bottom: South Polar Cap in Summer

# Mars Surface – evidence of water

Mars in the past?

An artist's conception



Ancient Mars?



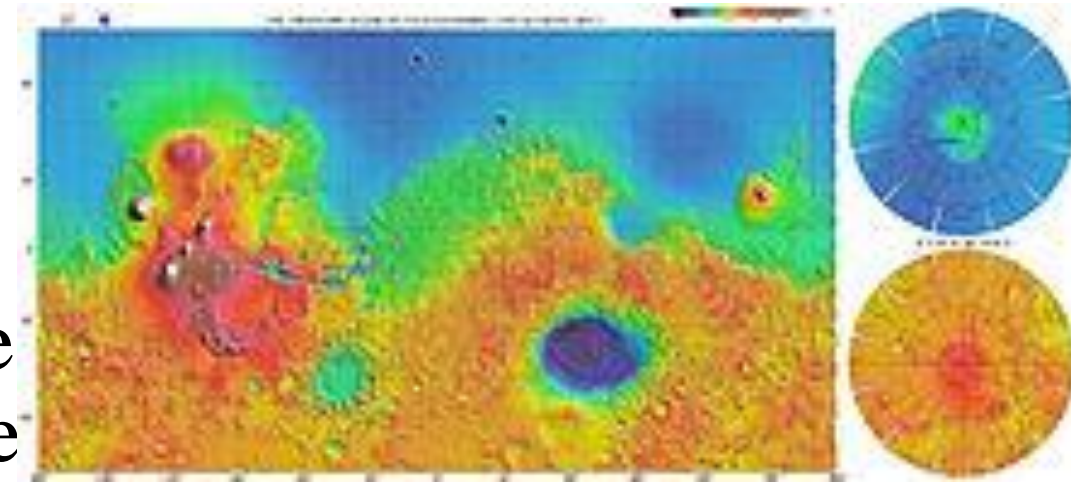
# Mars' Geography

## One uplifted region

Tharsis

Four giant volcanoes, including Olympus Mons  
Valles Marineris adjacent to Tharsis

Relatively smooth northern hemisphere  
– elevation is 4 km lower than the more  
heavily cratered southern hemisphere



Topographic map of Mars –  
Tharsis and Olympus Mars  
are to the left



# Mars' Atmosphere



Mars' thin atmosphere

96 % carbon dioxide

2 % argon

2 % nitrogen

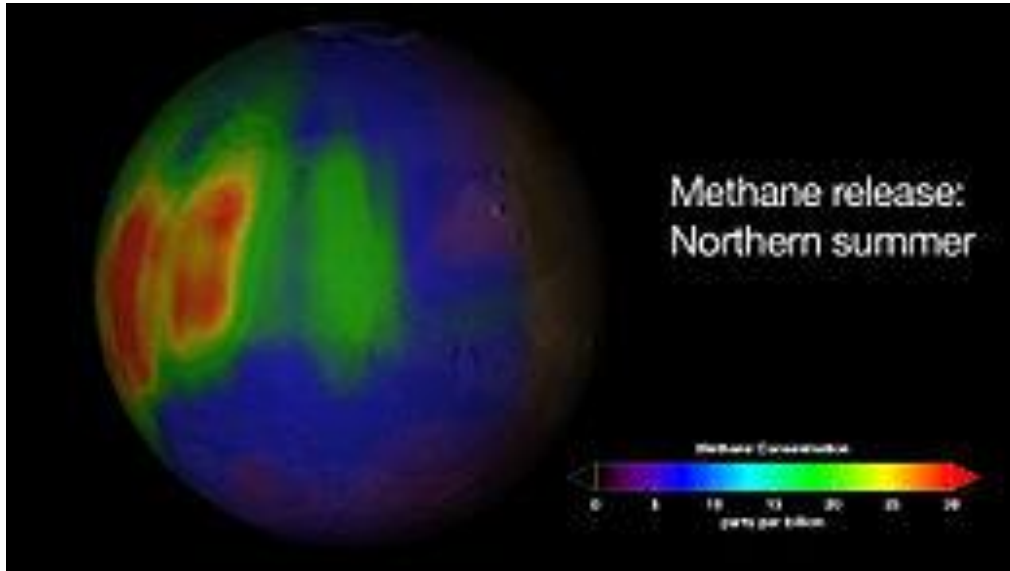
Trace of other gasses including oxygen and water

Surface temperature of 210 K, but can vary 80 K colder or warmer depending on season

Atmospheric pressure 0.6 % of sea level pressure on Earth

Quite dusty

# Mars' Atmosphere



Methane Detection on Mars

Methane has been detected intermittently since 2004  
Seems to be released seasonally  
Removed quickly from the atmosphere by reaction with solar UV radiation  
Origin – geophysical or biological?

# Why Are They So Different Now?



Venus



Mars

Two terrestrial planets, one almost identical to the Earth in mass and diameter, one about half the size of Earth.

The distance of each from the Sun is not radically different than Earth's distance.

Models suggest that both would have been Earth-like early in their history, perhaps with oceans and possibly life.

We know now that Mars clearly had surface water for extended periods.

# Venus – a runaway greenhouse effect

Gradual solar warming



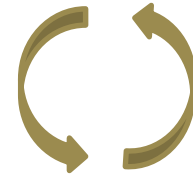
Increase in Venus' temperature



Increase in evaporation and an increase in greenhouse gasses



Increase in temperature and more evaporation



Ultimately, oceans “boil” away and carbon dioxide baked out of rocks



Solar UV breaks water molecules into hydrogen and oxygen, hydrogen lost to solar wind

# Mars – the opposite

A smaller planet, Mars' interior cooled more rapidly than Earth or Venus



Early magnetic field dwindled due to solidification of core



Solar wind began to impact the atmosphere and sweep away atmospheric molecules



Decrease in greenhouse gasses



Water begins to freeze on the surface



Ultimately, Mars becomes too cold and the atmosphere too thin for liquid water to exist on the surface

# Earth Like Planets

End of Chapter



Olympus Mons on Mars