

Welcome to Class 13: Was (Is?) Life on Mars?

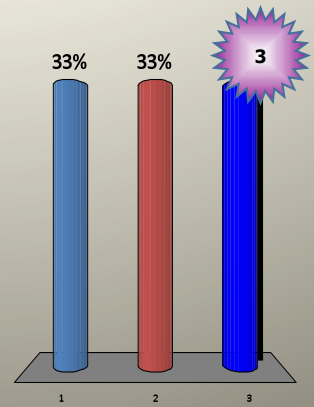
Why couldn't Mars maintain a warm, wet climate?
If life does exist on Mars where might we find it?



What Mars might look like with liquid surface water..

Which learning objective seems the most challenging?

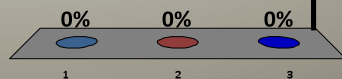
1. Instability of liquid H₂O on Mars now & why it was stable in past.
2. Evidence and explanation for current liquid H₂O on Mars.
3. Role of Mars' size to its lost warm/wet climate, why life may have started in past.



Remember to set your channel to 80!

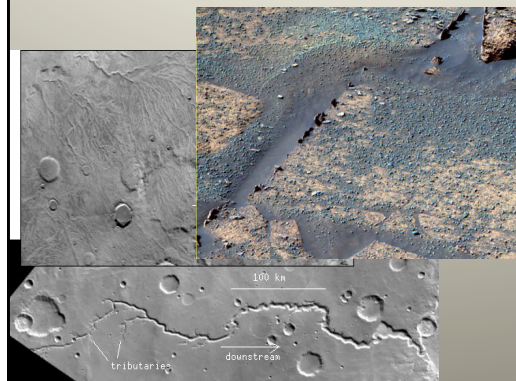
NASA is very interested in knowing if liquid water presently exists on Mars. Why?

1. For long term survival of humans trying to live there
2. It might indicate Martian life may have existed there.
3. It might indicate Martian life is now underground.



Evidence of PAST running water on Mars

Most believe liquid water ran on Mars's surface > 2-3 B.Y.A.
What supports this? Dendritic channels, dried up pools, flow patterns



More Recent Imaging:
Blue hematite stone ('blueberries'):

These only form in the presence of liquid water.

However, their ages are not known.

We have not returned rocks from Mars, but we have Mars rocks!

About 34 meteorites have been identified as coming from Mars.

How did they get here?

Launched by a major impact into space

How do we know they're Martian?

Unique Martian chemistry, isotopic ratios

Radiometric aging tells us:

Some are young, a few 100 m.y.o.
Others are over 4 b.y.o.

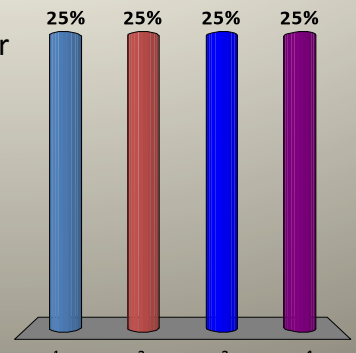
They show water processes.

Water has even been extracted from some of these meteorites.

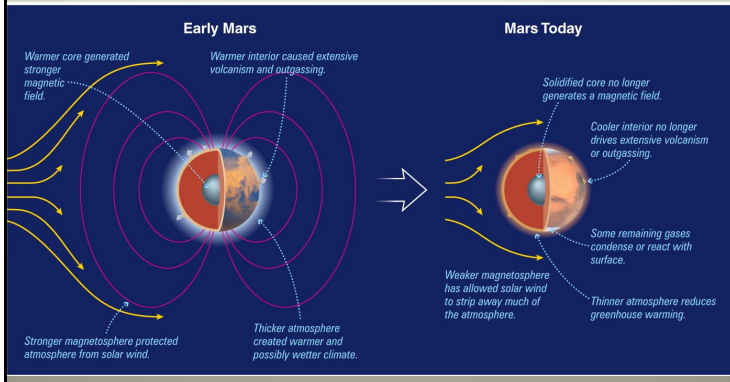


What **started** the change so Mars's surface no longer has liquid water?

1. Cooling off of its inner core (lost volcanism).
2. Reduction of water bearing comets.
3. Increased solar wind.
4. Its all now frozen.

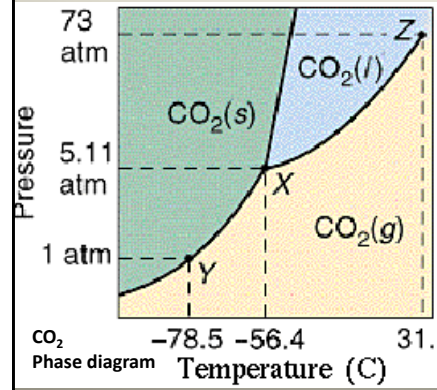


What happened when Mars's core solidified?



Mars lost its atmosphere when it cooled

Demonstration time!



What is dry ice?

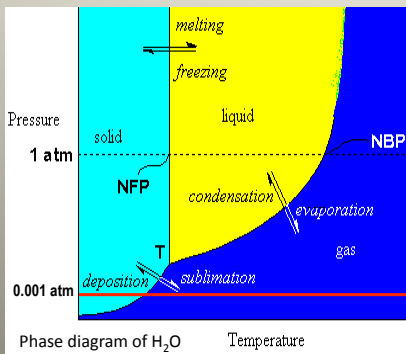
Solid CO_2

It's not until very high pressures, 5x that of Earth's surface, that CO_2 will have a liquid phase.

CO_2 gas is transparent. Why do we see a 'gas' coming off the solid sample?

A liquid phase does not always 'exist'

You understand phases based on range of temperature, only. That's because you have always lived at a single pressure.



Earth's surface = 1 atm

NFP = Normal Freezing Point

NBP = Normal Boiling Point

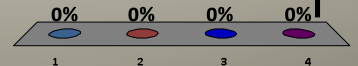
Anyone know the pressure on Mars?

1/100th that of Earth!

What would be required for liquid water to exist on Mars's surface?

Why is there not *liquid* water on the surface of Mars today?

1. The water is all gone.
2. It never gets warm enough to melt it.
3. Too little atmosphere.
4. The water only exists at the poles as solid ice



What about early Mars?



Global volcanism for the first billion years would have provided:

- 1) Liquid metal core to produce a magnetic field
- 2) Significant outgassing for a dense atmosphere
- 3) CO_2 and possibly other greenhouse gases

An environment which supported SURFACE LIQUID WATER

It is expected that Early Mars was very similar to Early Earth!

How soon after Earth formed was there evidence for life?
< 1/2 Billion years.

There is evidence that Water Flowed for over a billion years on Mars.

- * Did life take hold, if only briefly?
- * Has life survived underground?



Where is all the Mars water now and is it available for life?

Some is in the ice caps. Some is under ground. Much of it was lost forever to space:

How?

- Atmospheric water vapor was stripped by the solar wind.
- Ultraviolet light (blocked by Ozone on Earth) breaks atmospheric water into Hydrogen and Oxygen atoms. Oxygen oxidizes (rusts) the surface or combines to make CO_2 . Hydrogen is lost to space.

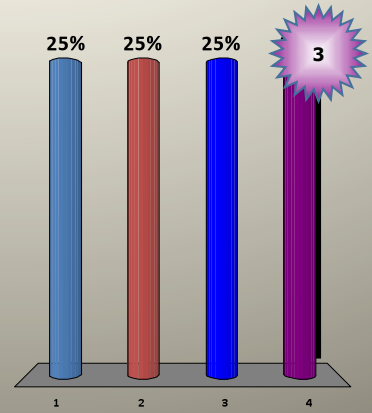
If Mars's surface was habitable for an extended time early on, life may have took hold sufficiently deep to embed itself underground and even exist there now.

Surface water on Mars now: at the poles, in craters near the poles (below) and in the atmosphere.



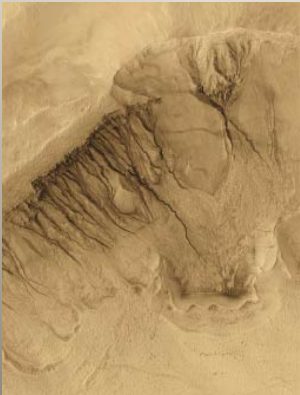
Where might one find *liquid* water on Mars today?

1. In the atmosphere.
2. On the surface.
3. On the poles
4. Deep Underground



Evidence for underground liquid water

Below ground, high pressure and temperature means water can exist as a LIQUID. It even appears for a brief time on the surface.

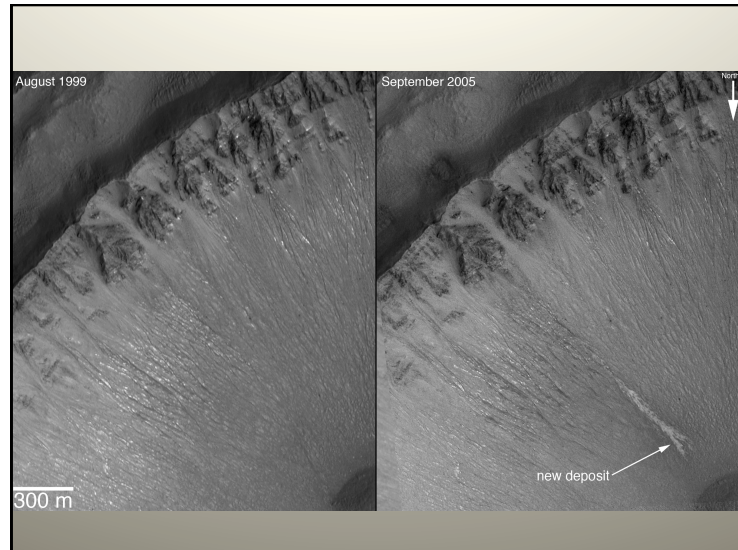


How can this happen if the liquid phase is not stable?

Have you ever seen an ice cube sitting at room temperature?

The phase diagram shows us where states exist in *equilibrium*. An ice cube sitting at room temperature will on its own change to the equilibrium state of a liquid.

Might these 'gullies' be old, representing a time when there was a more dense atmosphere on Mars?

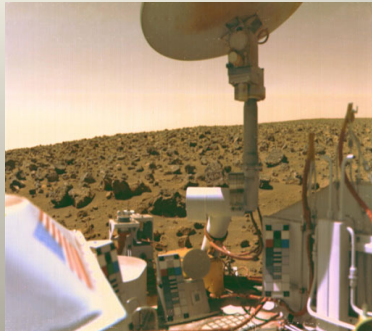


What have searches for life on Mars told us?

Direct studies of its soil

NASA's Viking missions to Mars (1976) (orbiter and a lander)

- 1) Obtained the first high res. images of Mars surface.
- 2) Characterized the structure and composition of the atmosphere and surface.
- 3) Conducted on-the-spot biological tests for life.



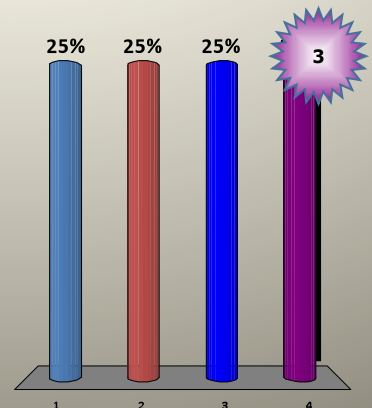
Three biological tests were consistent with life, but a chemical (mass spectroscopy) test showed the surface ENTIRELY VOID of organic molecules.

This indicated that life was not there. More so, this indicated that life could NOT survive on or near the surface presently.

Where might one find *Life* on Mars today?

1. In the atmosphere.
2. On the surface.
3. At the poles
4. Deep Underground

Note: this is virtually the same question I asked you searching for liquid water



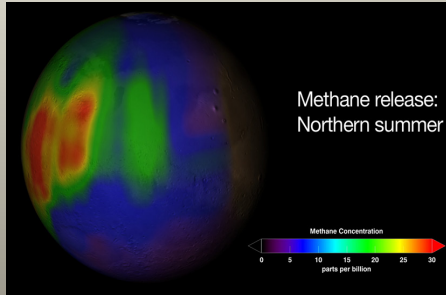
Further tests/indicators for life on Mars

Detection of Methane in Mars Atmosphere: In 2004, scientists announced they had detected methane gas

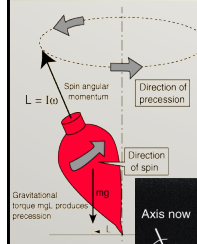
Methane is destroyed in the open Martian air in a matter of years. Its existence indicates it's currently being resupplied from the Martian surface.

Underground microbes might be creating it, or created it in the recent past. Life might be present deep under the surface of Mars even today.

It's *also possible* that methane is being created by *geologic* processes, via volcanism or rust, and not any life forms.



A moon is for more than romance

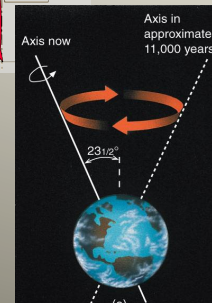


What good is a massive moon?

Gravitational force (torque) on spinning Earth causes angle of tilt (precession) to stay the same.

Mars has no massive moon to keep TILT the same. Mars's tilt can change drastically!

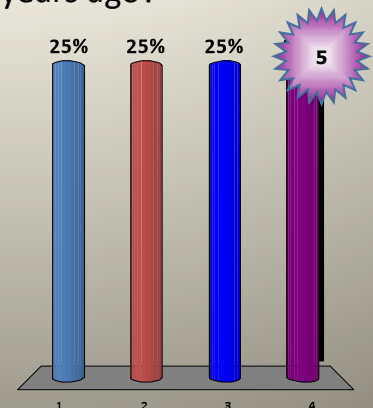
Variable tilt is NOT good for life (remember snowball Earth?)



The end of class quiz

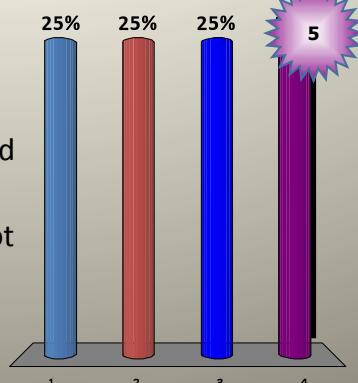
1. In which characteristic were Mars and Earth similar 4 billion years ago?

1. Length of year
2. Geological activity
3. Radiation from sun
4. Diameter



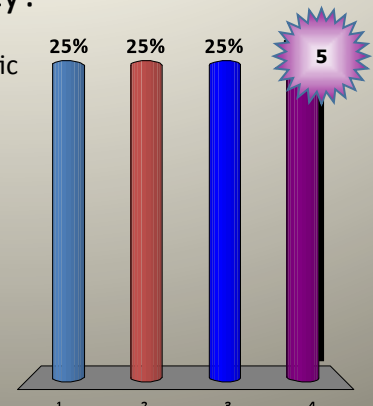
2. Why is water vapor on Earth NOT destroyed by UV radiation from the sun?

1. Too far from the Sun
2. The water is stronger
3. UV radiation is blocked by ozone
4. The UV radiation is not strong enough.



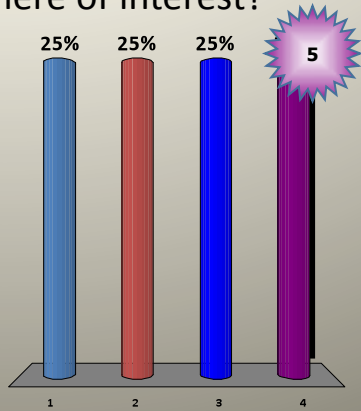
3. What was the effect on Mars of losing its geological activity?

1. It lost its strong magnetic field.
2. Liquid water was no longer stable on the surface.
3. It no longer had geo-outgassing to maintain an atmosphere.
4. All of the above.



4. Why is the presence of methane gas in the Mars atmosphere of interest?

1. It must be actively resupplied
2. It is a valuable greenhouse gas
3. It indicates surface water is on Mars
4. It proves life is on Mars.



5. Why is Earth's tilt more stable than Mars?

1. Its more massive than Mars.
2. It has a stronger magnetic field.
3. Its volcanically more active.
4. None of the above.

