

Welcome to Class 12: Mars Geology & History

Remember: sit only in the first 10
rows of the room

What are we going to discuss today?

How easily could humans live on Mars?

Is there water on Mars?



PRS: If given the opportunity (and you might not return alive) would you want to visit Mars?

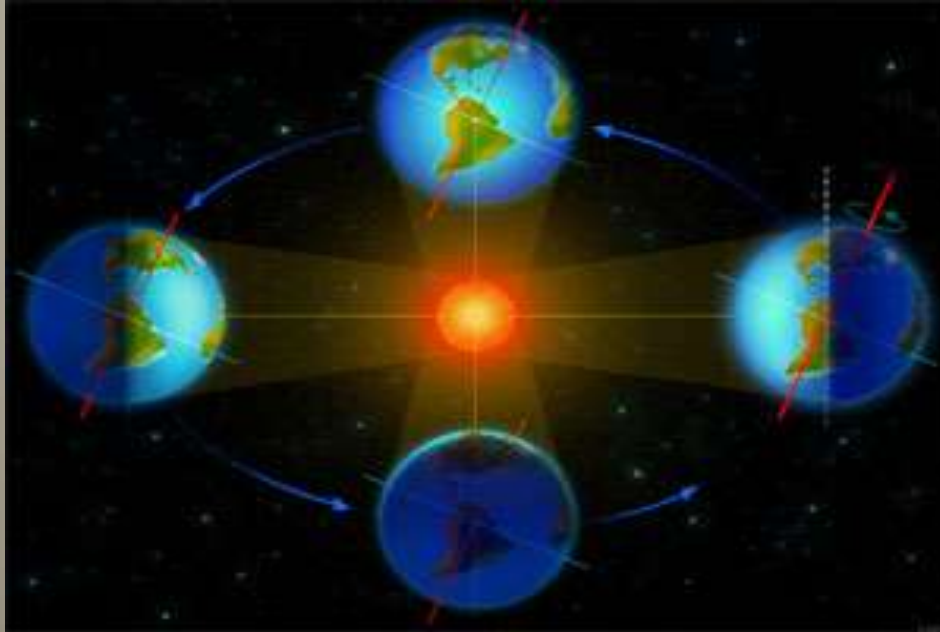
1. YES
2. NO

Remember to set your channel to 80!

Let's compare Mars to Earth

	Mars	Earth	Significance for life?
Average Distance from Sun	142 million miles	93 million miles	→ < ½ the solar radiation
Radiation Levels	VERY HIGH	Moderate	→ You'll need a space suit
Diameter	4,220 miles	7,926 miles	→ ½ Diameter, ¼ Volume
Tilt of Axis	25 degrees	23.5 degrees	→ Seasons!
Length of Year	687 Earth Days	365.25 Days	→ Longer seasons
Length of Day	24 hours 37 minutes	23 hours 56 minutes	→ Nice for humans
Gravity	.375 that of Earth	2.66 times that of Mars	→ You can walk with that heavy space suite
Temperature	Average -81 degrees F	Average 57 degrees F	→ You'll need a space suit
Atmosphere	mostly carbon dioxide some water vapor	nitrogen, oxygen, argon, others	→ You'll need a space suit
# of Moons	2	1	→ 2x Romantic night skies

Let's compare the 'seasons' and weather on Mars and Earth



Earth's seasons are caused by the tilt of its rotational axis – (almost) ONLY

On Mars, there is a similar tilt, but the orbit is not so circular.

This makes the Northern Winter and Southern Summer very brief and extreme.

Mars 'weather' is driven by events at the polar ice caps (CO_2 , but some H_2O ice).

- The extreme temperature differences sublimates ice from the Summer Cap, while atmospheric CO_2 directly deposits from the air on to the Winter Cap ice.
- This sets up **enormous pressure differences**, pole to pole, driving strong winds and dust storms back and forth.

PRS: What color is the Martian sky
(as seen from its surface)?

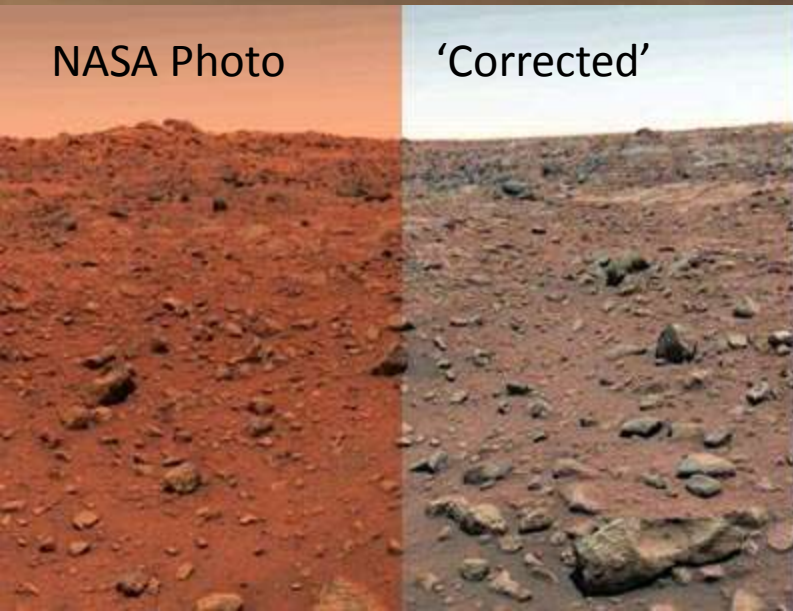
1. Black
2. Blue
3. Green
4. Orange

Like on Earth, the color of Mars's sky depends on weather and time of day

Normally, the dusty air casts a brown-orange color. If dust content is low, the sky may appear blue or even greenish, particularly when the sun is low. Yes, those are clouds of water vapor.

NASA Photo

'Corrected'



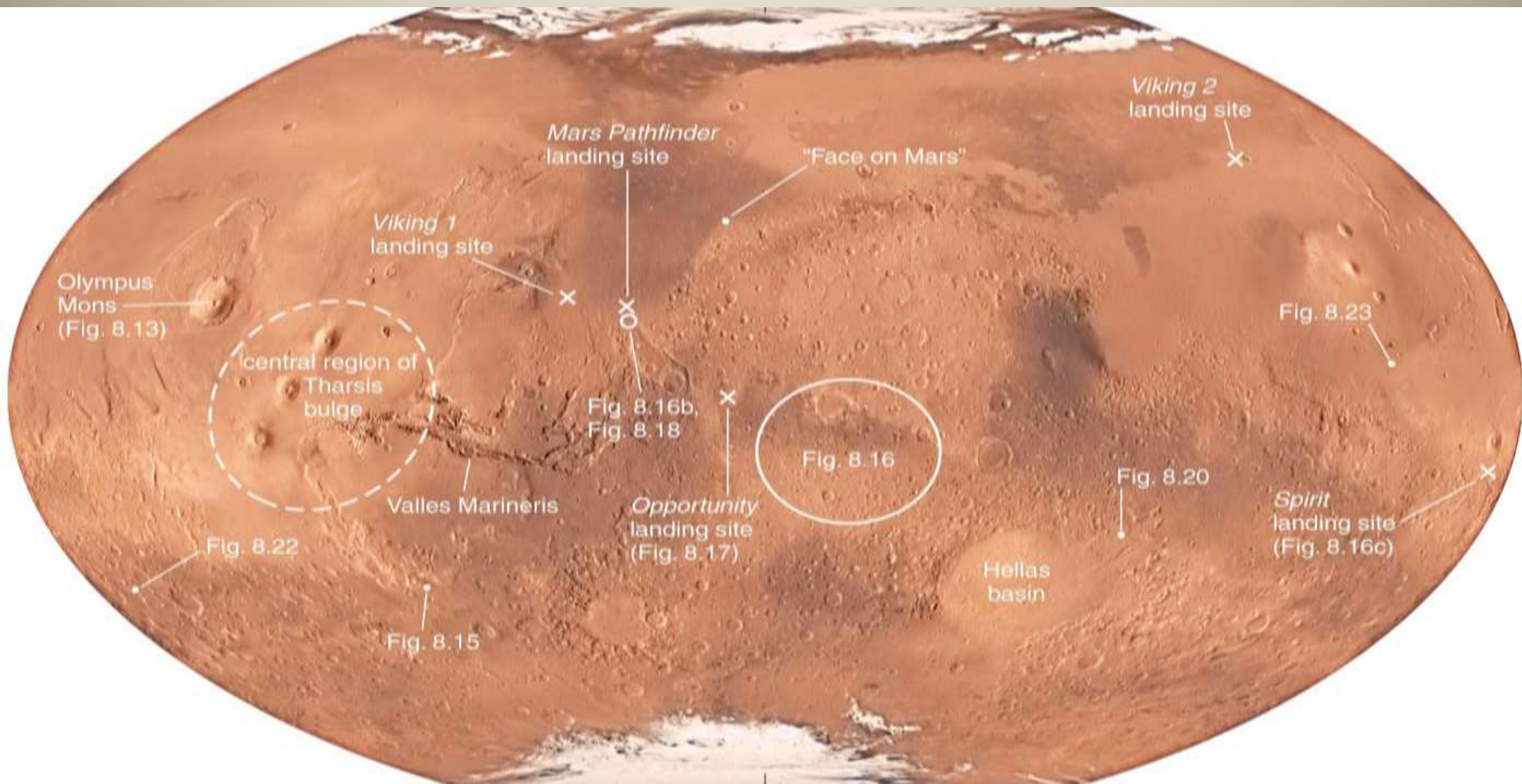
On the web you will find many sites who claim NASA has deliberately set the colors to make the sky look red-pink (and that its true color is blue).

NASA does this, presumably, to hide that the images were taken in Arizona (standard conspiracy theory).

Is Mars Geologically Active?

Mars is small, but there is evidence for activity:

- The N. hemisphere is clear of large impact craters.
- There are features characteristic of lava flows.
- There are towering Volcanoes!



PRS: Recall the Hawaiian Island chain. How would that hotspot look if the upper plate never moved?

1. It would plug up and stop producing lava
2. It would simply form a single normal island.
3. It would form a single island that was *very* large.

Behold! Olympus Mons!

A 27 km high Volcano

- Hawaii, 9 km to seafloor

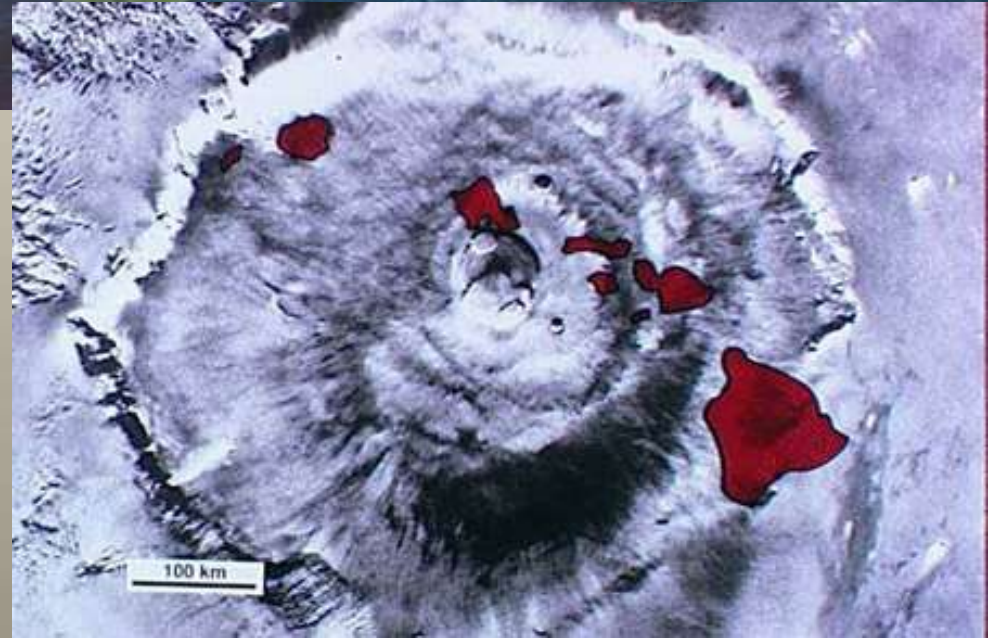
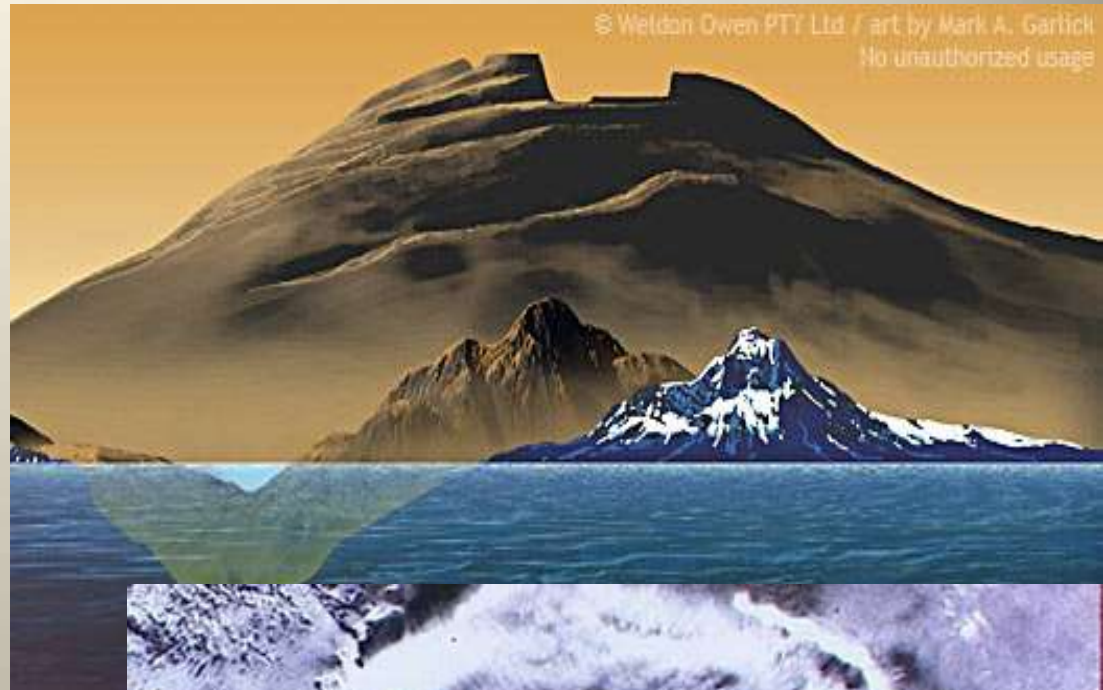
- Mt Everest, 8.9 km

WHY SO BIG?

1) No plate tectonics.

2) Gravity on Mars is 1/3 that on Earth.

Here is a top view comparison of Olympus Mons vs. the Hawaiian Islands.



PRS: When you look at Mars's surface features what can you already tell?

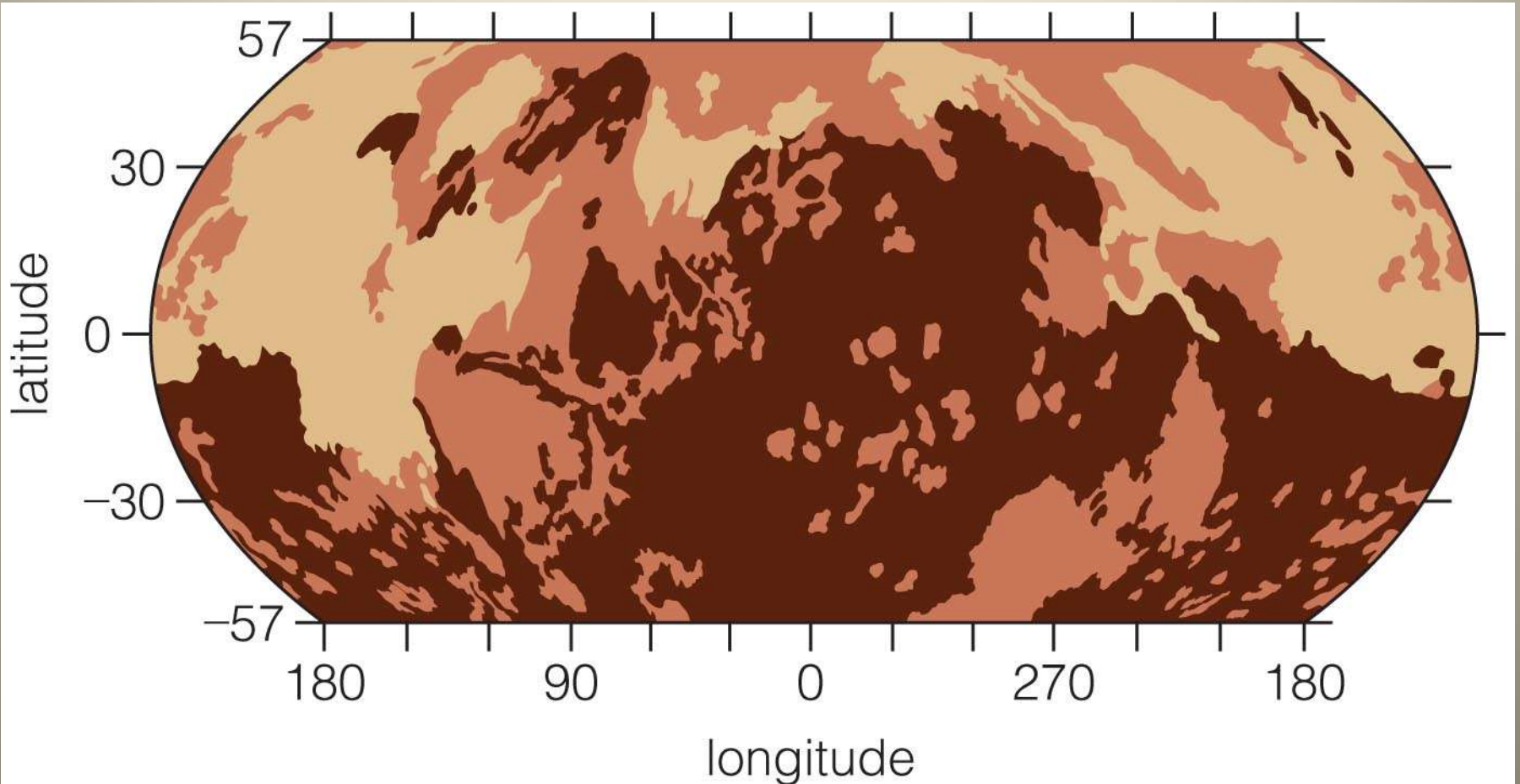
1. Life can live there.
2. Its geological activity has declined.
3. There was once running water on its surface
4. Liquid water may exist below the surface

What happened to the Volcanism?

Dark areas: 4.6-3.8 B.Y.O.

Pink areas: 3.8-1.0 B.Y.O.

Tan areas: < 1.0 B.Y.O



Surface geology indicates evidence of a decrease in volcanism dating already by 3.5 B.Y.O. However, Martian meteorites indicate molten lava ~ 180 M.Y.A. Maybe not dead yet.

PRS: NASA is very interested in determining if Water 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.

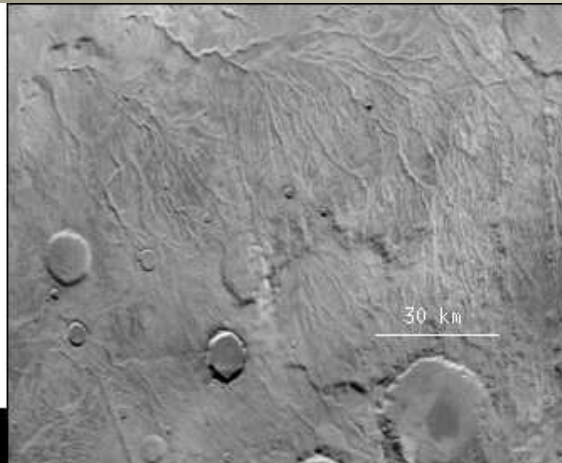
What supports this? Dendritic channels, dried up pools, flow patterns



Blue hematite stone ('blueberries'):

These form in the presence of water.

Their ages are not known.

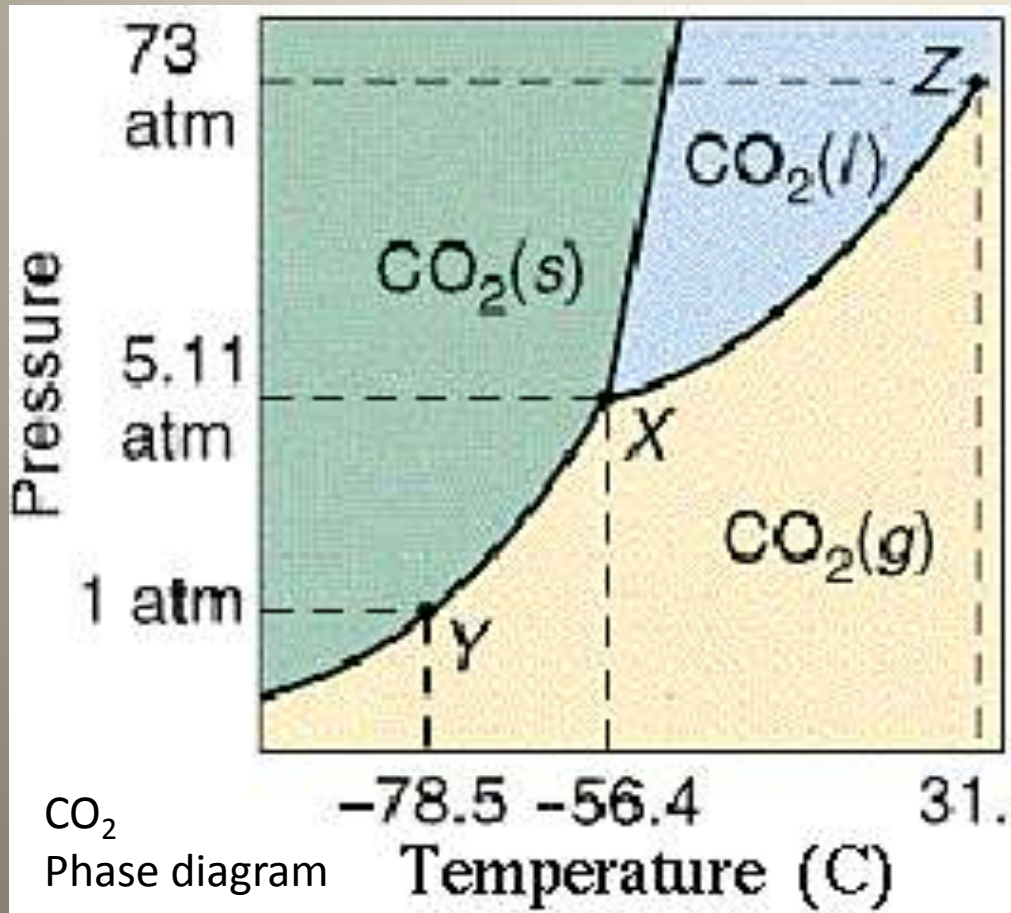


We have no returned rocks from Mars, but we have Mars rocks!

PRS: 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

Demonstration time!



What is dry ice?

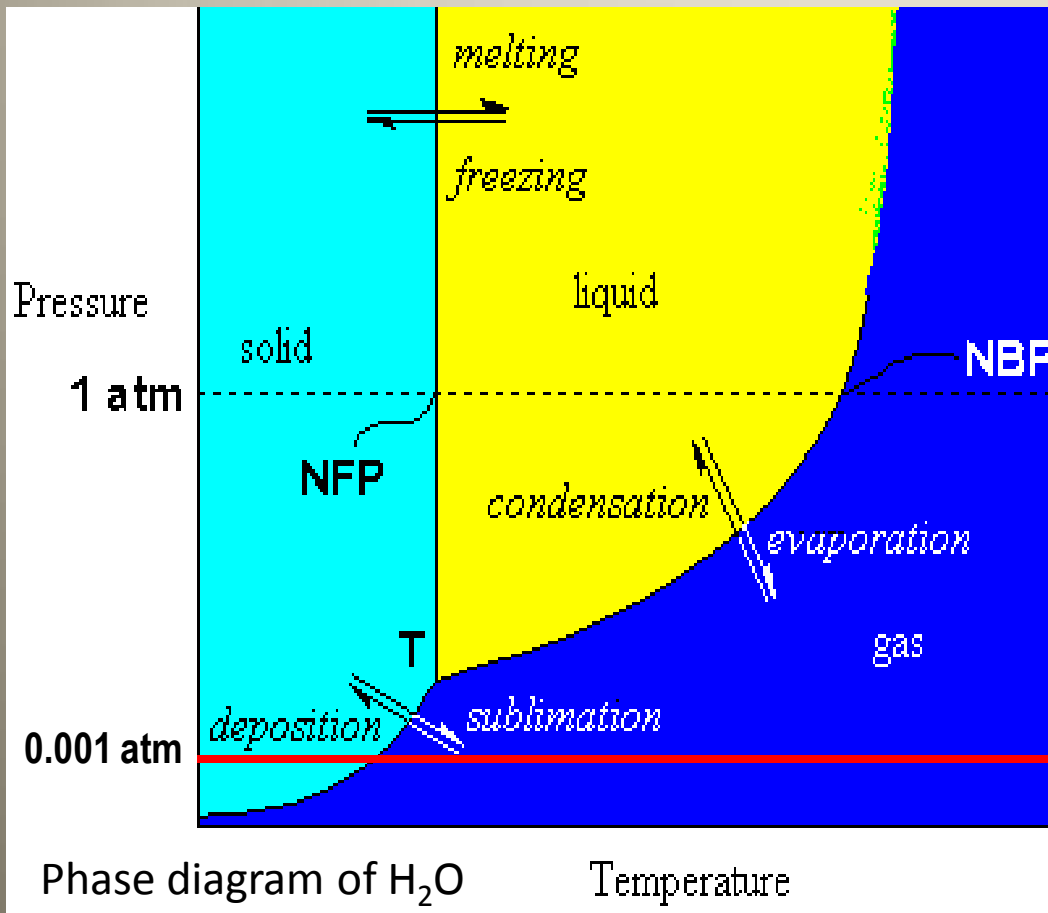
Solid CO₂

It's not until very high pressures, 5x that of Earth's surface, that CO₂ will have a liquid phase.

CO₂ gas is transparent. Why do we see a 'gas' coming off the solid sample?

The 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

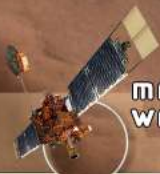
NBP = Normal Boiling Point

Anyone know the
pressure on Mars?

1/100th that of Earth!

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

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



**MARTIAN
WATER ICE**

YEAR: 2004

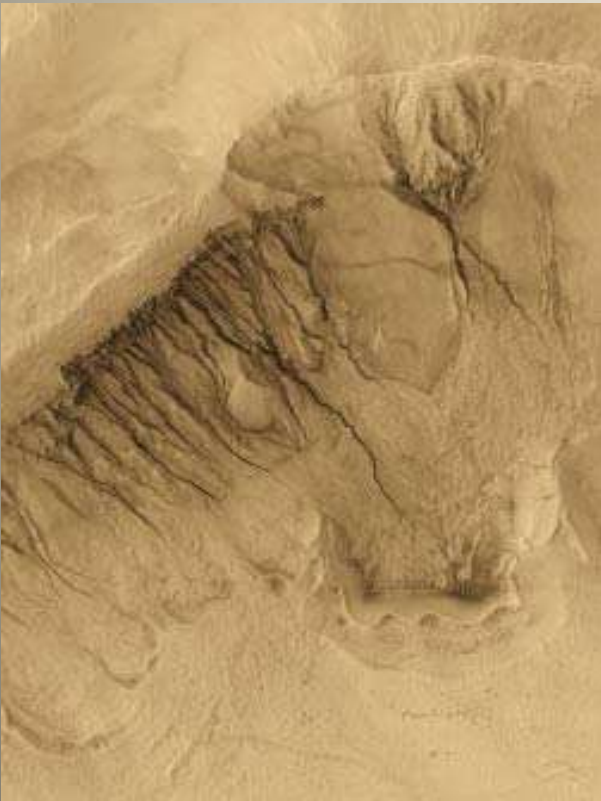
MISSION: MARS GLOBAL SURVEYOR

TARGET: MARS

Where all the Martian water went is still one of the big mysteries on Mars. However, there are some places where water can still be found – frozen at the two poles and in some craters near the poles.

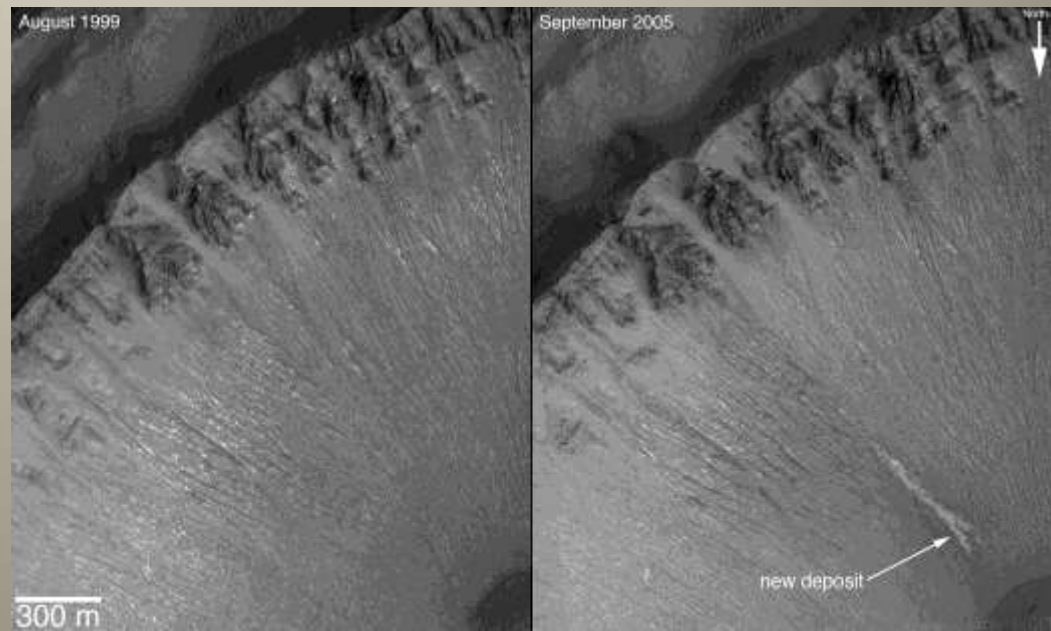
AND.. what about below ground?

Below ground, increased pressure and temperature means water can exist as a LIQUID. At times, it even appears for a brief time.



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

PRS: What has changed that Mars's surface no longer has liquid water?

1. Loss of geological activity.
2. Reduction of water bearing comets.
3. Increased solar wind.
4. Its all now frozen.

Put all your materials on the floor and
place your PRS clicker in front of you.

Please: use just one clicker for yourself.

Take care that others can not
view your selection

1. In which way are Mars and Earth similar?

1. Number of moons
2. Diameter
3. Chemistry of atmosphere
4. Tilt of axis

2. What does it mean if a large region lacks impact craters?

1. The surface is very old
2. Fewer impact occurred there
3. The region has been resurfaced with lava
4. The impacts are too small to measure

3. Which is NOT evidence of Mars PAST geological activity?

1. Volcanoes
2. A magnetic field
3. Lava flows
4. Large regions lacking impact craters

4. Why does Mars have the largest volcanoes in the Solar System?

1. It is a dense planet
2. It has two moons
3. The surface gravity is very low
4. It has no magnetic field.

5. What existed in Mars's early history to allow it to maintain liquid water at its surface?

1. Volcanism
2. A magnetic field
3. Greenhouse atmosphere
4. All of the above

For Class 13

- Read assigned textbook pages, guided by the reading questions.
- Attempt answering the learning objectives after reading the textbook.