

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

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

What are we going to discuss today?

Why didn't Mars maintain a warm, wet climate?

If life could exist on Mars where would we find it?



PRS: In what key (life supporting) characteristic is Earth different from Mars?

1. Oxygen atmosphere
2. Greater solar Radiation
3. Orbital tilt
4. **Geologic Activity**

Remember to set your channel to 80!

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) CO₂ 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?

< ½ Billion years.

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

* Did life take hold, if only briefly?

* Or has life survived underground?



Evidence for running water on Young Mars



We discussed already the geological features seen on the surface. Is there other evidence?

Almost 50 meteorites have been identified as coming from Mars.

How do we know this?

Their Martian chemistry, specifically: isotopic ratios

How did they get here?

Launched into space from a major impact.

Rocks are aged using radiometric dating.

Most are young, less than 1 billion years.

ALH 0084 is over 4 billion years old.

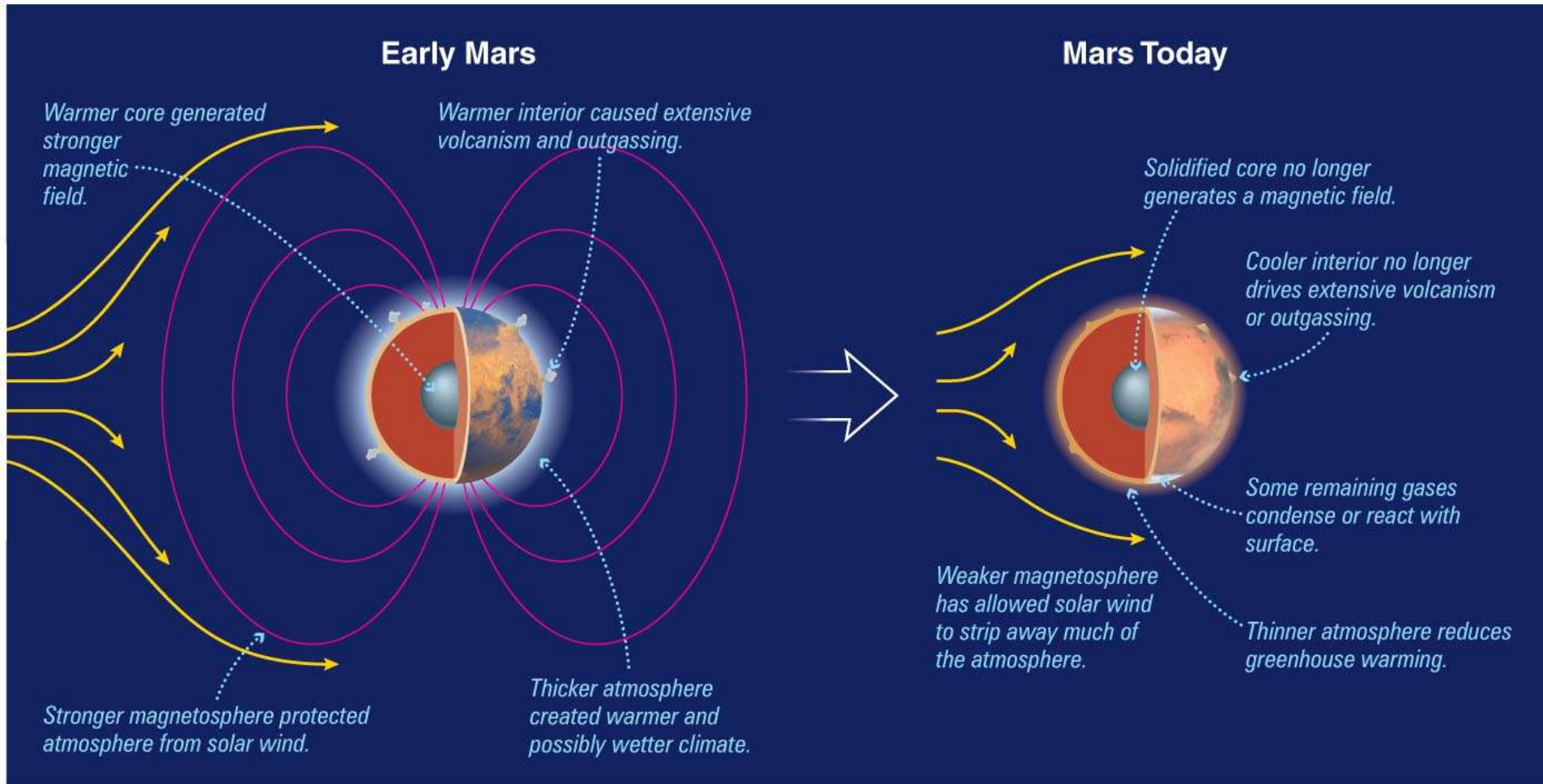
They show water processes. Scientists have even *extracted water* from one meteorite.



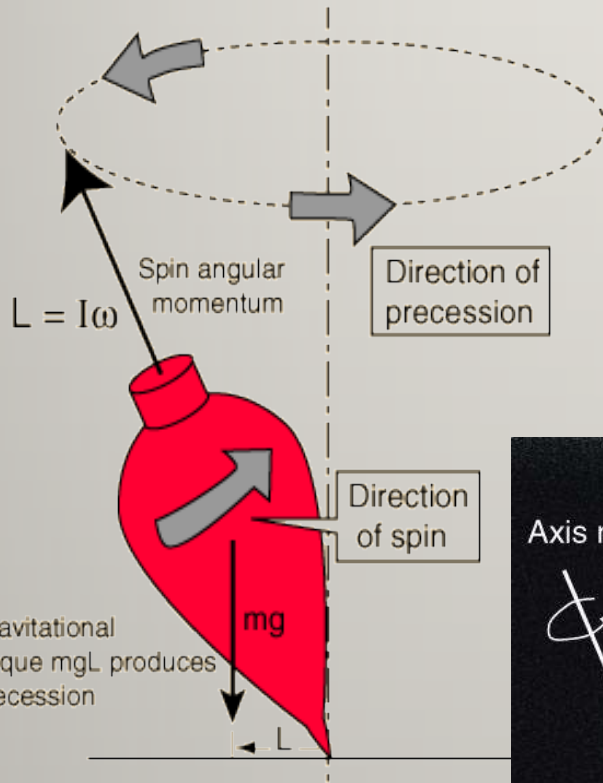
PRS: Why did Mars eventually turn dry and cold on its surface like it is today?

1. Central fusion reactions stopped
2. The Sun cooled off
3. The center cooled
4. The atmosphere became too thick.

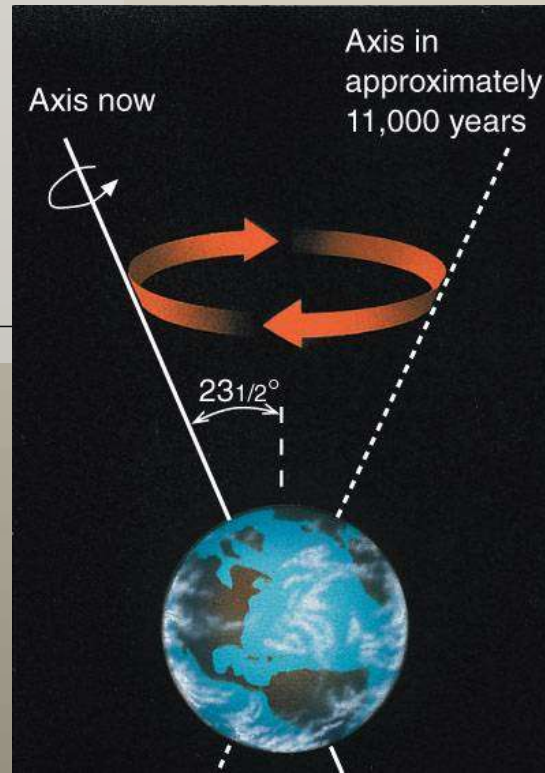
What happened when Mars's core solidified?



Demonstration time!



What good is a massive moon?
Gravitational force (torque) on spinning Earth causes tilt (precession actually) to stay.



Mars has no moon to keep TILT the same. Mars's tilt changes, sometimes drastically!

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

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 CO₂. 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.

PRS: Where can one find *liquid* water on Mars today?

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

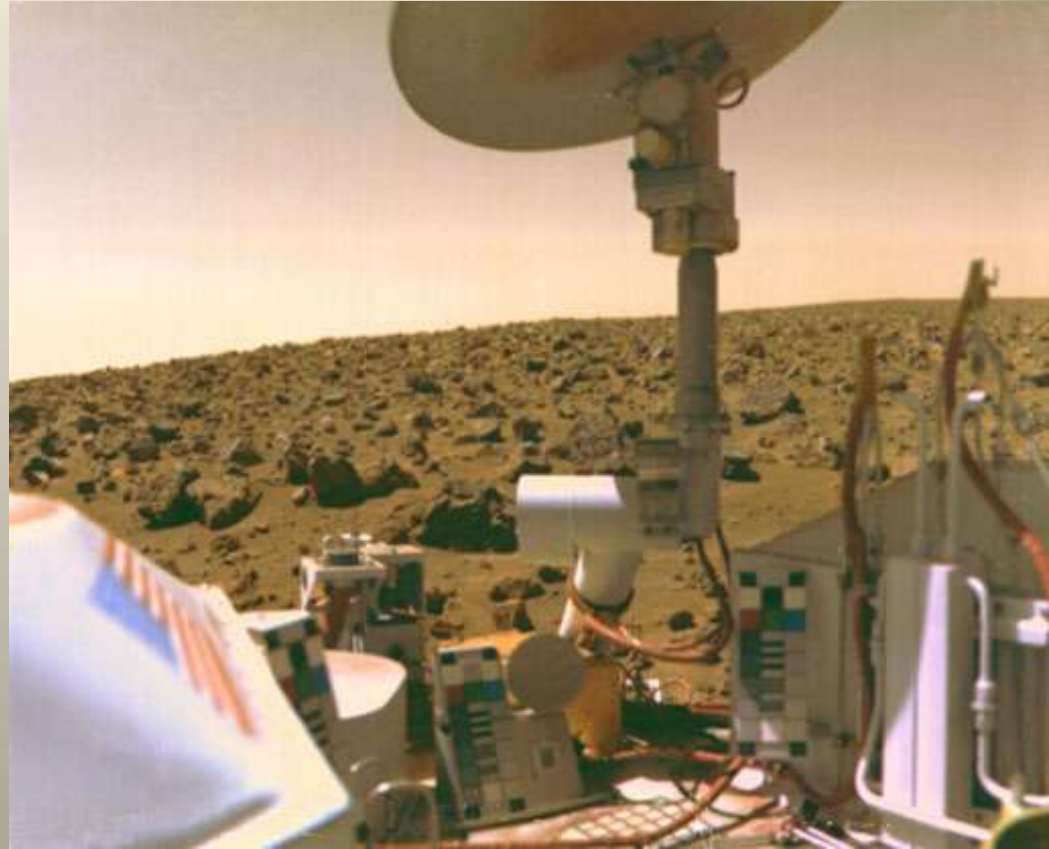
What have searches for life on Mars told us?

There have been **THREE** tests/indications for life on Mars.

1) Direct studies of its soil

NASA's Viking missions to Mars in 1976, consisted of an orbiter and a lander. They obtained the first high res. images of Mars surface, characterized the structure and composition of the atmosphere and surface, and conducted on-the-spot biological tests for life.

Three biological tests were consistent with possible life, but a final test showed the surface **ENTIRELY VOID** of organic molecules of any kind.



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

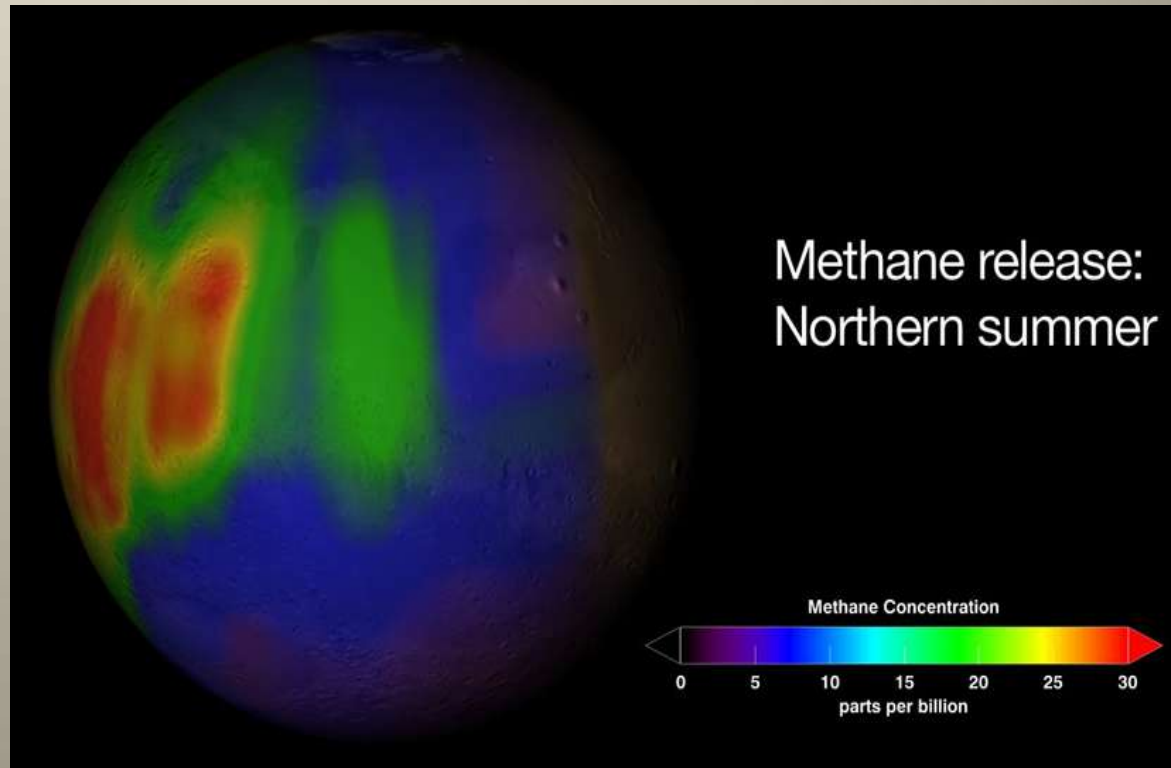
Further tests/indicators for life on Mars

2) 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.

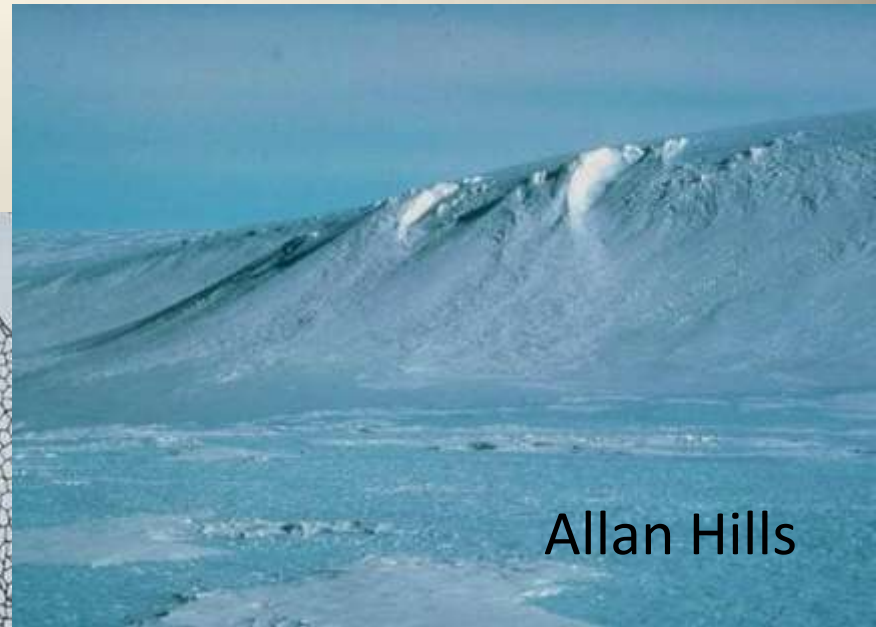
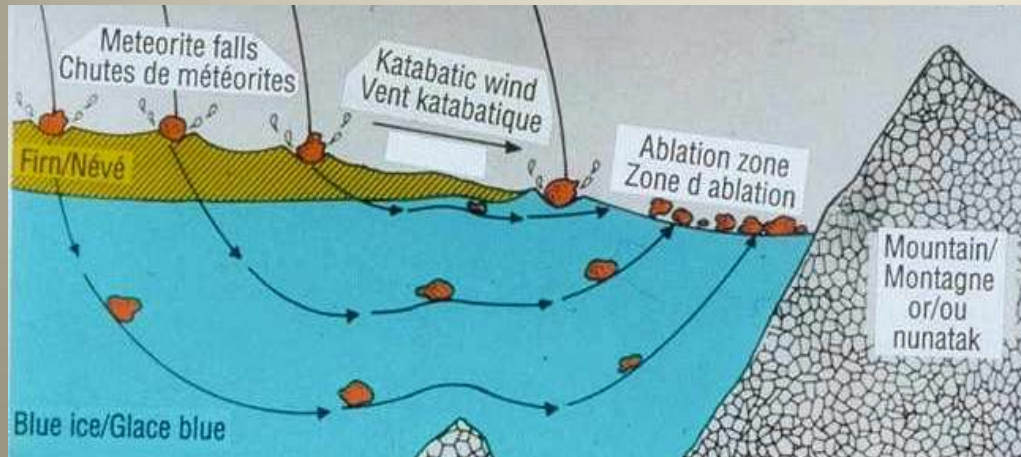
Underground microbes might be creating it, or created it in the recent past. Life might be present under the surface of Mars even today.

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



3) Evidence from the Mars Meteorite: ALH84001

Antarctica is a great place to look for meteorites! Why?



Allan Hills



Tens of THOUSANDS of meteorites have been found in Antarctica.

ALH 84001 was the first meteorite found in the Allan Hills, in 1984. It was later recognized to have originated from Mars.

PRS: Most meteorites are found in Antarctica.
This is NOT because of _____

1. Concentrated searches
2. The rocks pile up next to mountain ranges
3. More meteorites fall there.
4. Easy to find dark stones in light colored ice.
5. All of the above is TRUE.

The story of ALH 84001

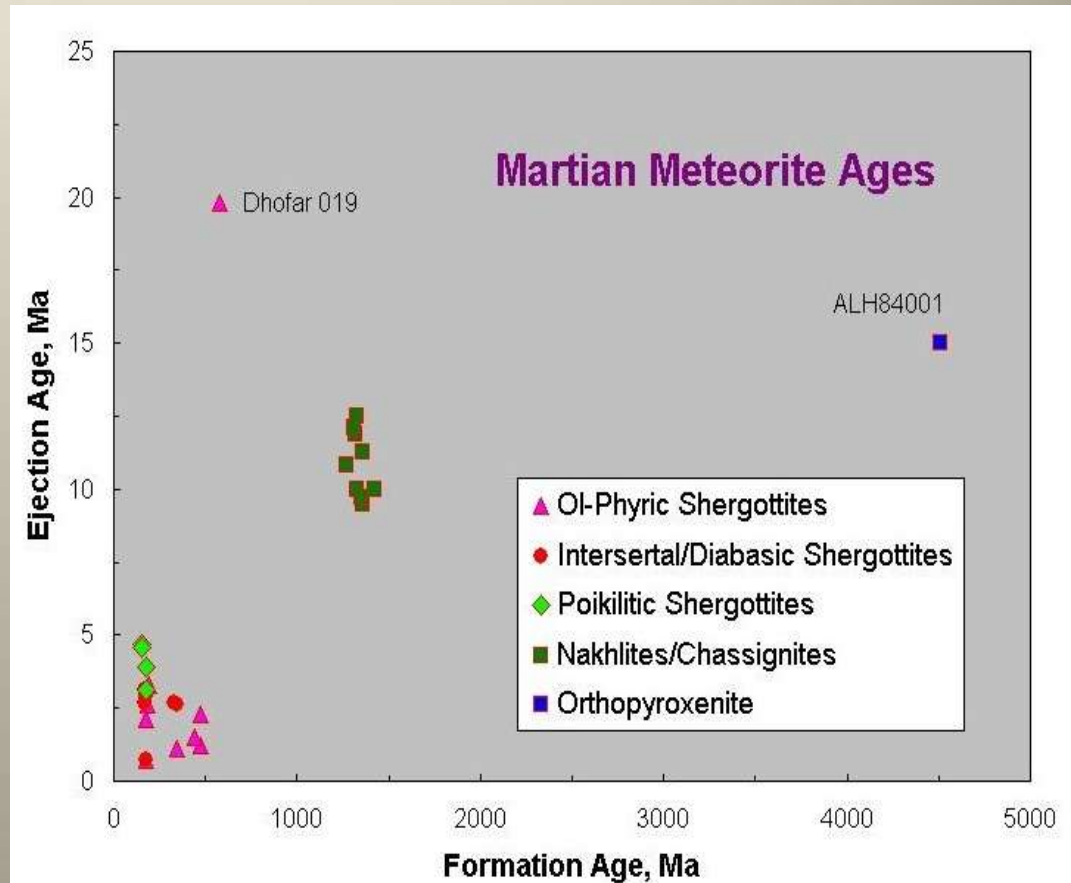
Unique oxygen isotope ratios (like ratios found by Viking Landers) linked ALH 84001 to Mars. Almost 50 Martian meteorites are known.

Like all Martian Meteorites:
ALH84001 was launched into space by a large impact millions of years ago.

Based on surface space weathering, scientists can estimate how long a meteorite was in space.

Unlike other MM: ALH84001 is VERY OLD. 4.5 billion years.

IMPORTANT: ALH84001 was the only sample 'there' when Mars was warmer and wetter.



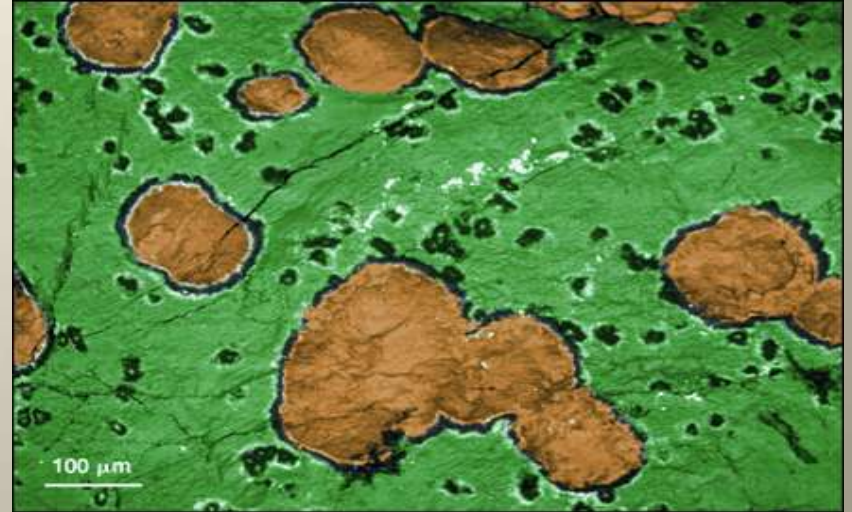
PRS: What unique characteristic of ALH84001 means we can study it for evidence of early life on Mars?

1. Its isotope ratio.
2. Its from Mars.
3. Its age.
4. Its from Antarctica.

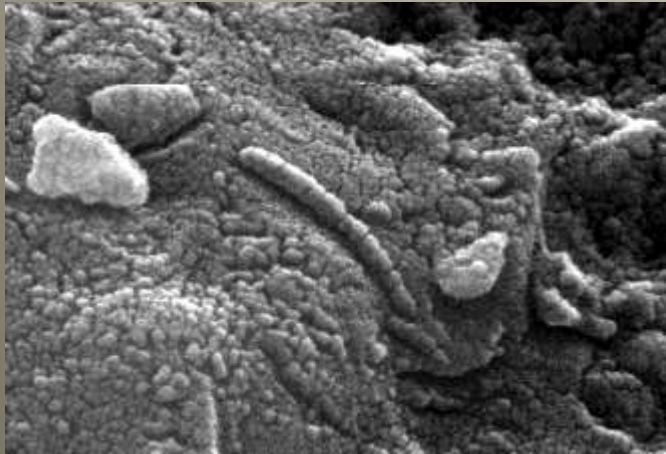
What did they find in the meteorite, ALH 84001?

Possible evidence for past life on Mars. What supports this?

- Layered structure in carbonate grains.
- Grains contained complex organic molecules.
- Magnetic crystals layered in the grains.



This CAN be created by geo-chemistry, but more *easily* created by life.



Perhaps the most visual evidence: these shapes *resembled* nanobacteria on Earth.

But even this evidence is not proof. Even nanobacteria on Earth are 'questioned'

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 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. 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.

4. Where is the best place to search Mars for CURRENT life?

1. In the atmosphere
2. In the ice caps
3. In the soil
4. Deep underground

5. Why was ALH84001 unique to other Mars Meteorites?

1. It is extremely old
2. It was thrown from the Mars surface
3. It contained water
4. It had unique isotopic abundances

For Class 14

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