PANSPERMIA:

COULD LIFE ON EARTH HAVE BEEN BROUGHT HERE FROM ELSEWHERE?

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class 5

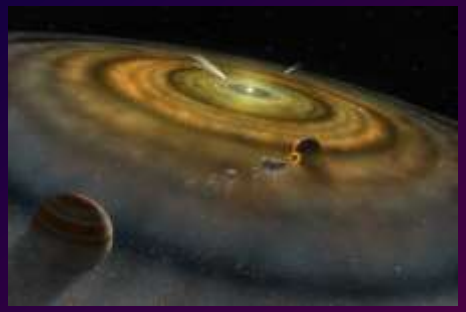
Panspermia Hypothesis: Life on Earth did not originate here, but was brought here from somewhere else in the universe soon after Earth formed.

What the Earth is thought to have looked like when it first formed, 4.5 Gy ago*

Gy = Giga years = billion years, or 10^9 years.
The universe is 13.8 Gy old.

View of Earth from space, as seen from orbit, some time in the 20th century.

Formation of the Solar System: ~4.5 Gy



Formation of our Moon by a Mars-sized body colliding with Earth, melting, and condensing in orbit: ~4.48 Gy

Hadean Eon

Evidence for a period of heavy bombardment and extended meteor showers striking the surface of the Earth between ~4.0 and 3.8 Gy

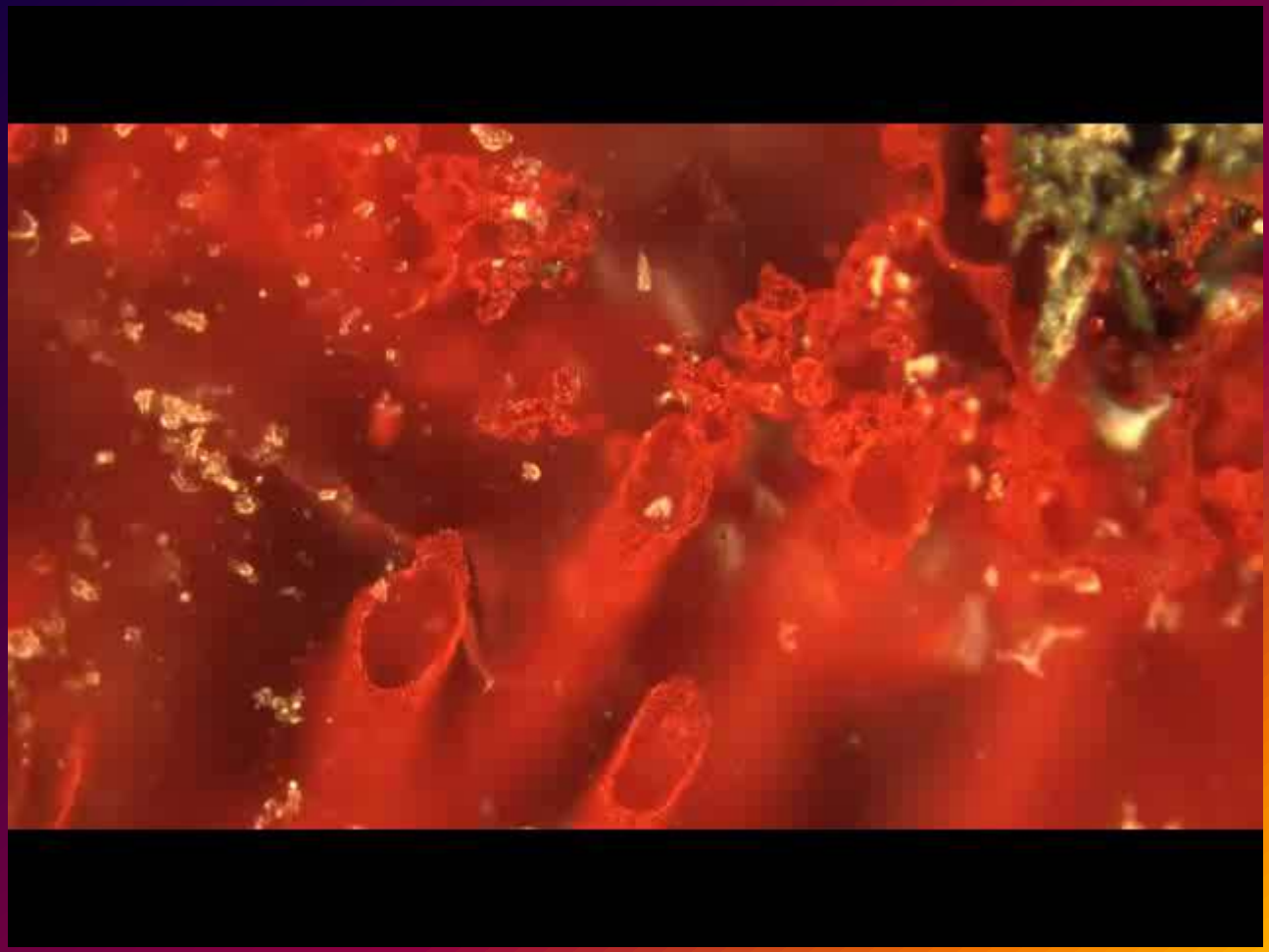
Archaean Eon

Evidence for biological activity in submarine hydrothermal vents between 3.77 and 4.28 Gy ago, overlapping with the period of heavy meteoric bombardment.

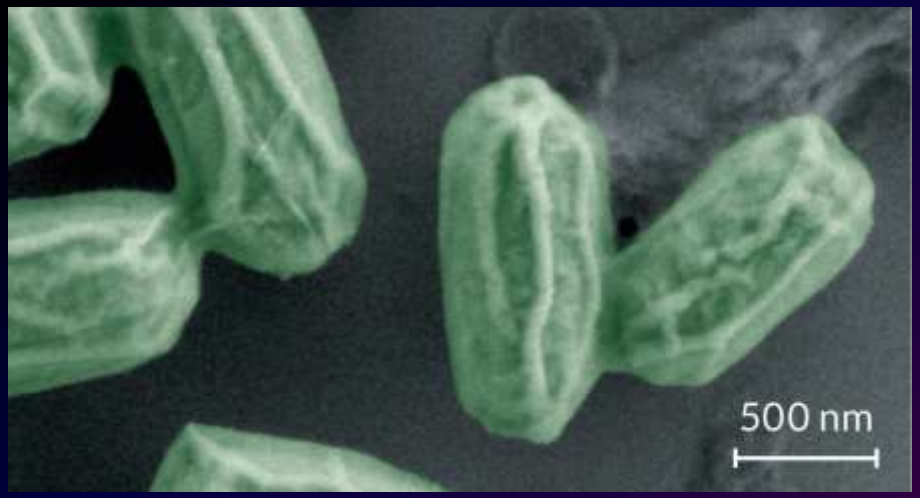
article published in Nature, March 2, 2017:

Evidence for early life in Earth's oldest hydrothermal vent precipitates

Matthew S. Dodd[1,2], Dominic Papineau[1,2], Tor Grenne[3], John F. Slack[4], Martin Rittner[2], Franco Pirajno[5], Jonathan O'Neil[6] & Crispin T. S. Little[7]



https://www.dailymail.co.uk/sciencetech/article-4268566/The-earliest-life-Earth-hydrothermal-vents.html

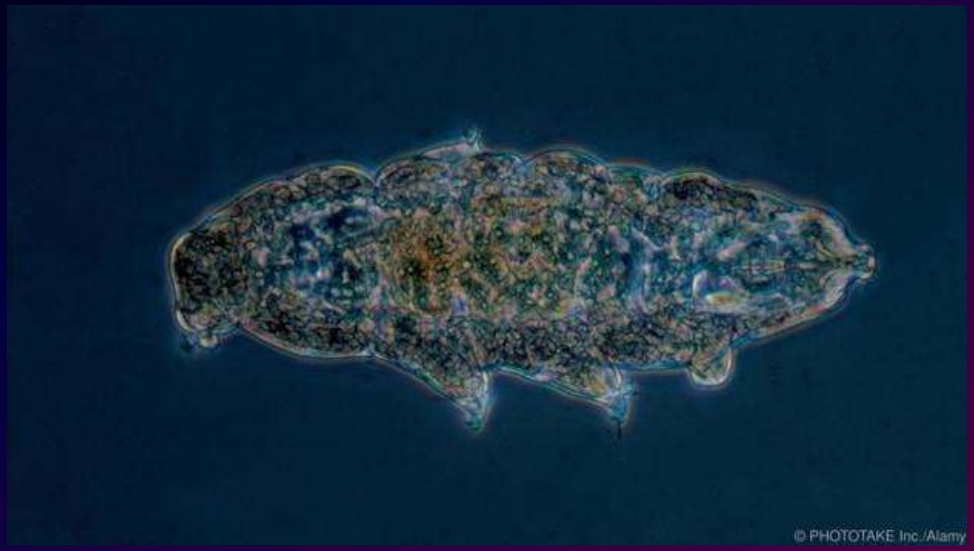


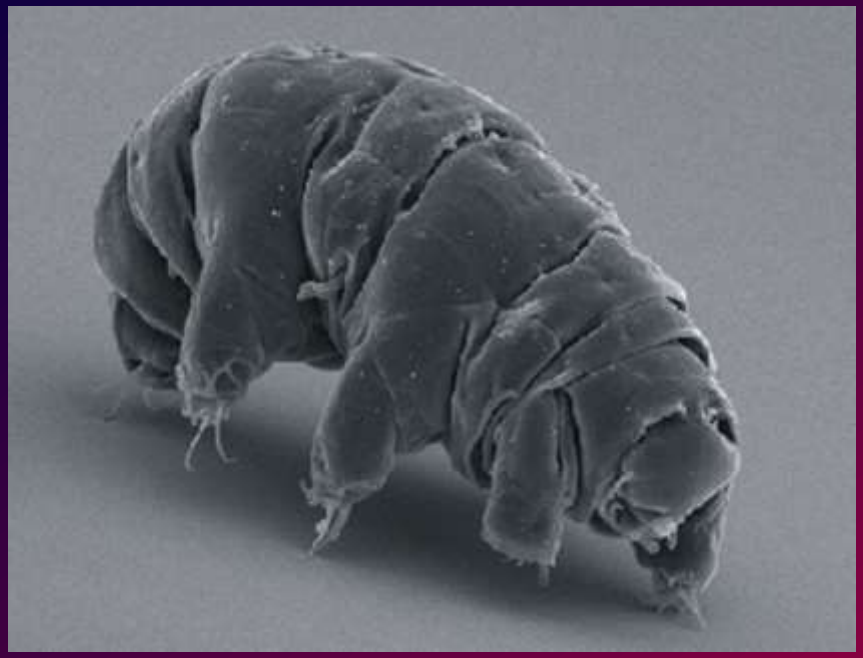
Studies have shown that Bacterial spores can remain viable for up to 250 million years. Could bacterial spores have come to Earth on comets?

Spectrum of radiation emitted from Halley's Comet's dust particles as the comet approached the sun correspond surprisingly well to that of bacteria heated to elevated temperatures.

https://helix.northwestern.edu/article/origin-life-panspermia-theory

Hardy species of Tardigrade, Milnesium tardigradum survived the vacuum of space.





Oldest fossil tardigrades found on Earth are 600 My old.

They appear to have first evolved in water on Earth, but...

...in their 'tun' state they dehydrate, curl up in a ball, and their metabolism slows to 0.01% of normal rate.

http://www.bbc.com/earth/story/20150313-the-toughest-animals-on-earth

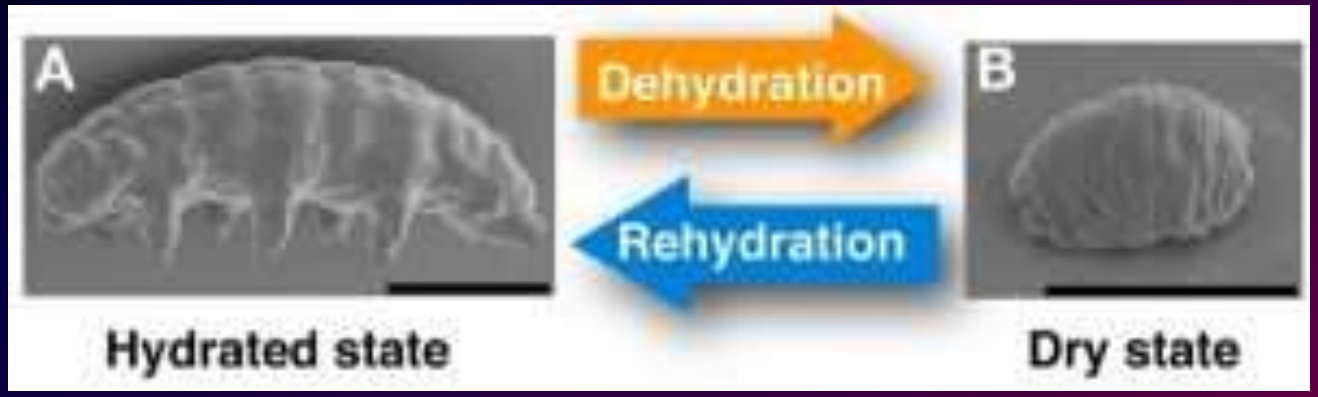


Image source: Science Daily Credit: 2016 Sae Tanaka, Hiroshi Sagara, Takekazu Kunieda.

Watch as a tardigrade goes into anhydrobiosis and rehydration:

https://www.youtube.com/watch?v=ejEUIVl9jXo

Meteorite called ALH84001 found in Antarctica in 1984 confirmed of Martian origin.

Theory holds that it was blasted off the surface of Mars 17 My ago and landed on Earth around 13,000 years ago.

Isotopic analysis indicates that the carbonates in ALH84001 were precipitated in 18^{o} C water, probably a shallow, gradually-evaporating body of water.

Electron microscope image reveals chain structures in a fragment of ALH84001 that some claim are of biogenic origin, similar to modern terrestrial bacteria.
Not conclusively confirmed to be biogenic.

Did life originate in other parts of our galaxy and arrive here on the backs of comets and/or meteors?

Are bacterial spores ubiquitous in our galaxy, and can they easily attach to comets?

Could life in stasis have survived being blasted off another planet by an impact, and hurtled through space, to land on Earth?

CHOICES OF RESEARCH TOPICS FOR STUDENT PROJECTS

1. Astrobiology – searching for signs of any life
2. Astronomy & Astrophysics – stars that can support life; life at high red shift
3. Exoplanets – habitable zones and possible ocean world
4. SETI: radio searches, history of SETI, radio telescopes around the world
5. OSETI: pulsed optical searches – go into detail about Harvard project
6. TPS - Continuous wave laser searches (Lubin)
7. Ethical considerations
    1. Planetary protection
    2. Impact on society
8. Hypothetical civilizations
    1. Lubin scale
    2. Kardhashev scale