



Neil F. Comins • William J. Kaufmann III

Discovering the Essential Universe

Sixth Edition

CHAPTER 15

The Search for Extraterrestrial Life

Biology based on organic molecules with silicon compounds?

Bad qualities - reactions take far too long to support the evolution of life



Figure 19-3b
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Meteorites – with organic molecules

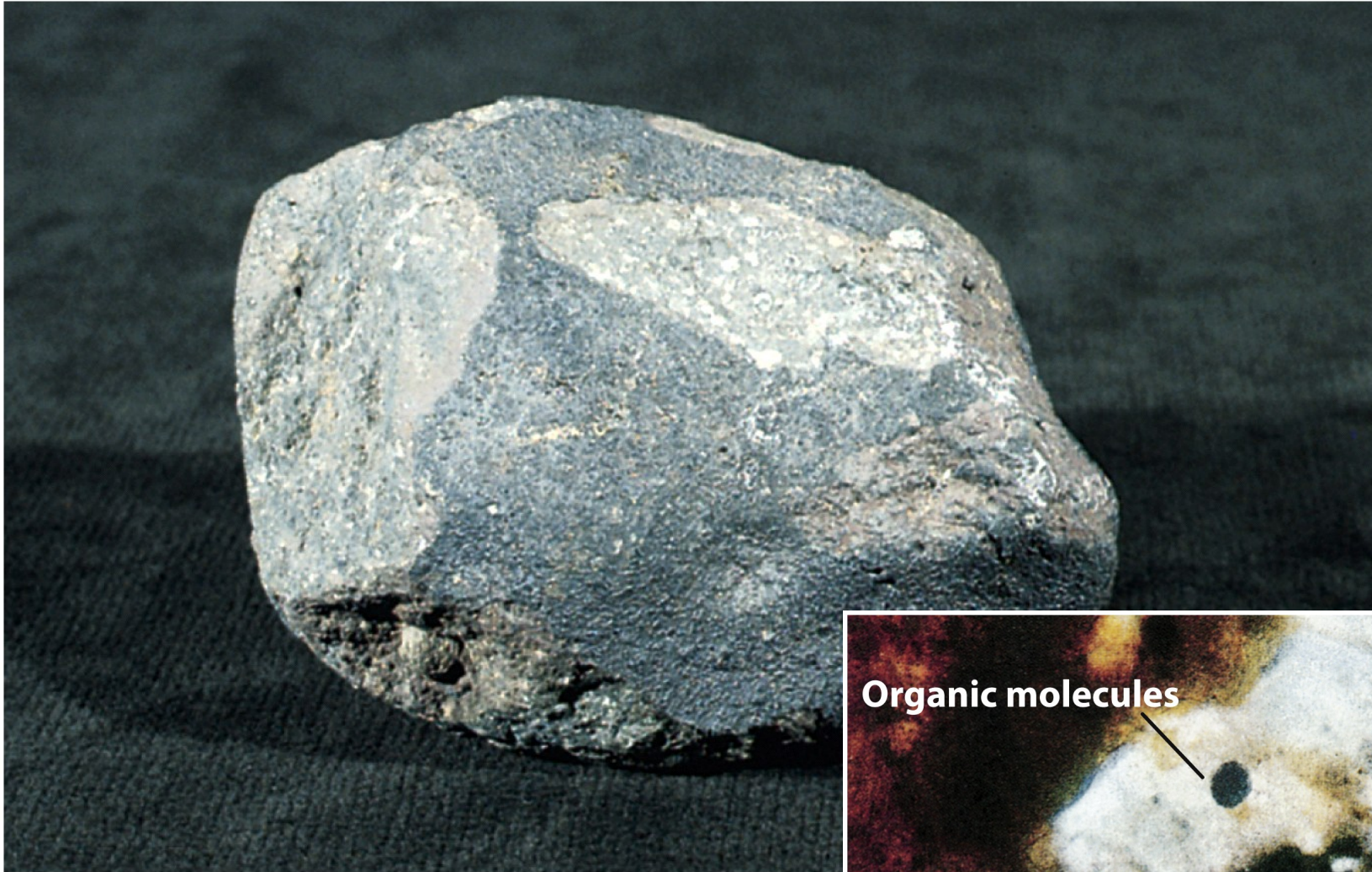


Figure 19-4a
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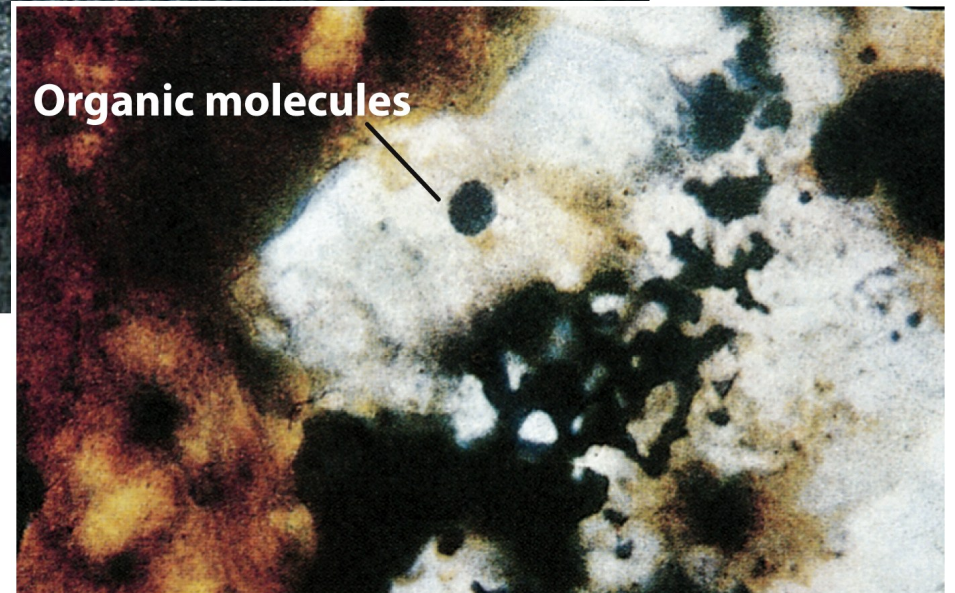
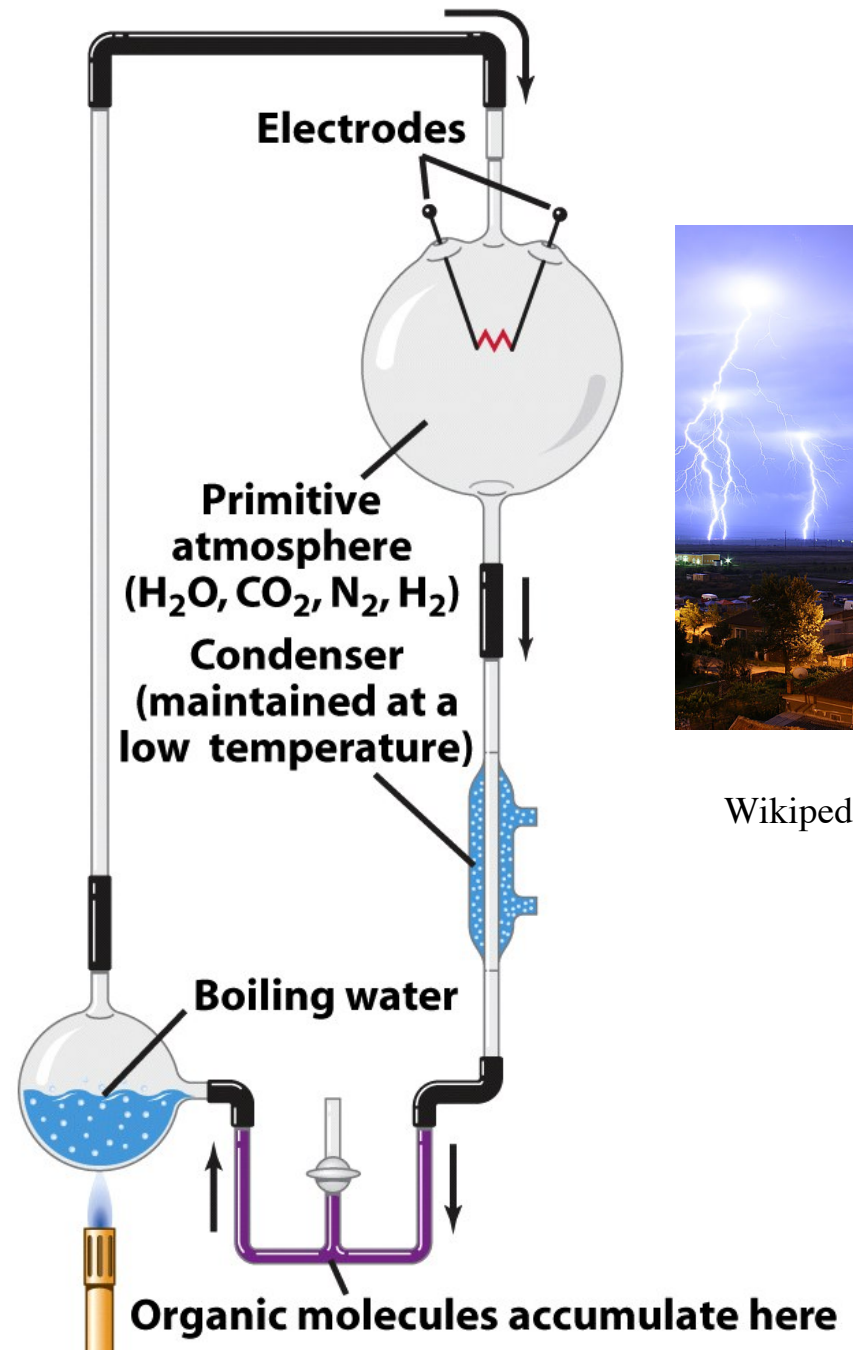


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The Miller-Urey experiment

It supports the hypothesis that life on Earth arose as the result of ordinary chemical reactions in Earth's primordial atmosphere



Wikipedia

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Life can develop in very hostile environments

Tube worms in 3km deep ocean in almost boiling water near vents

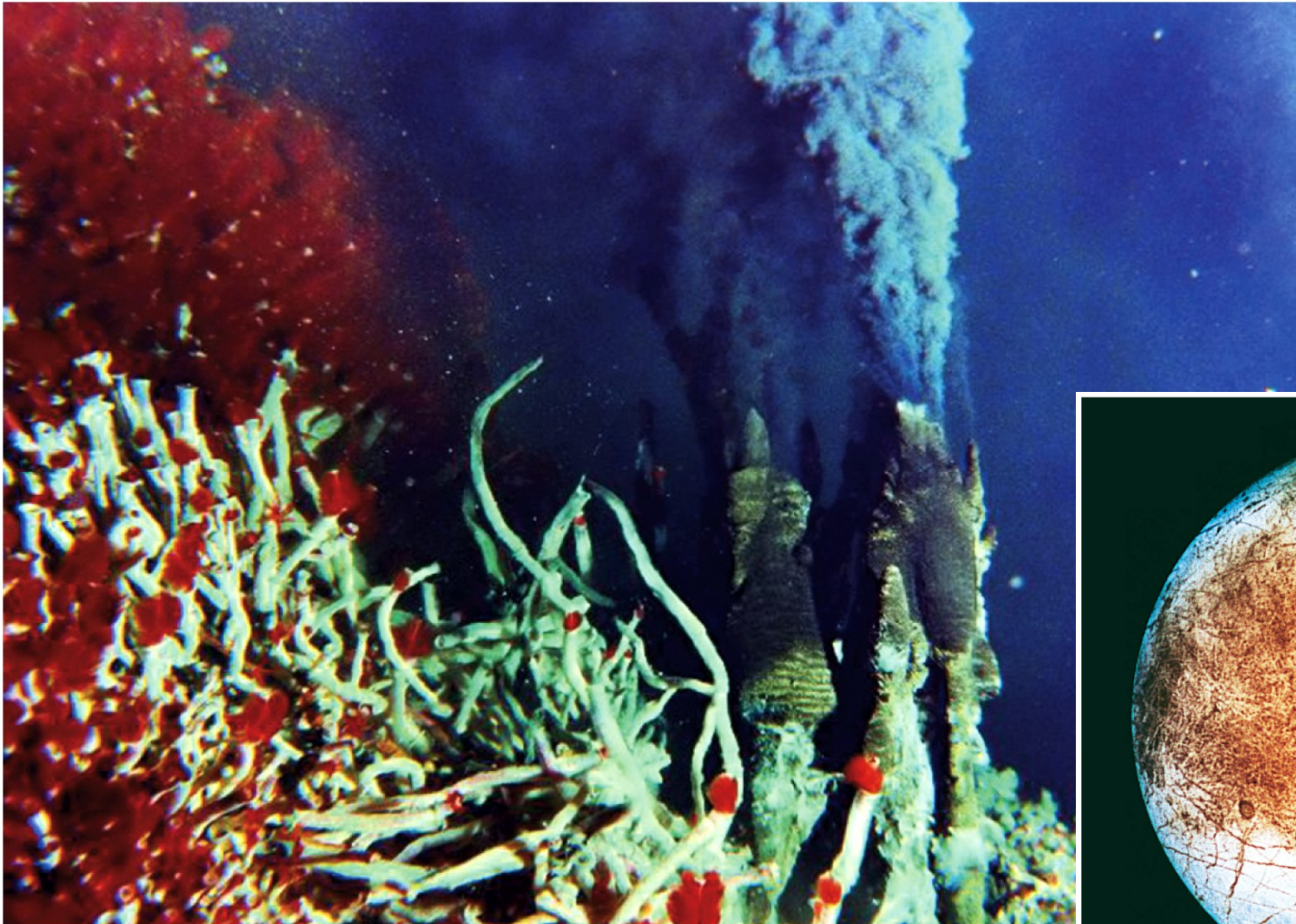
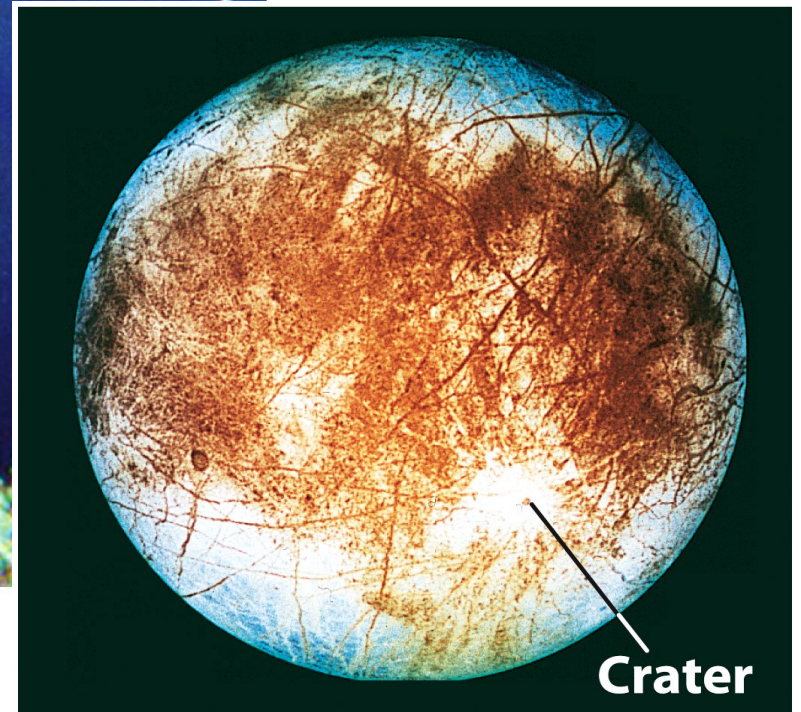
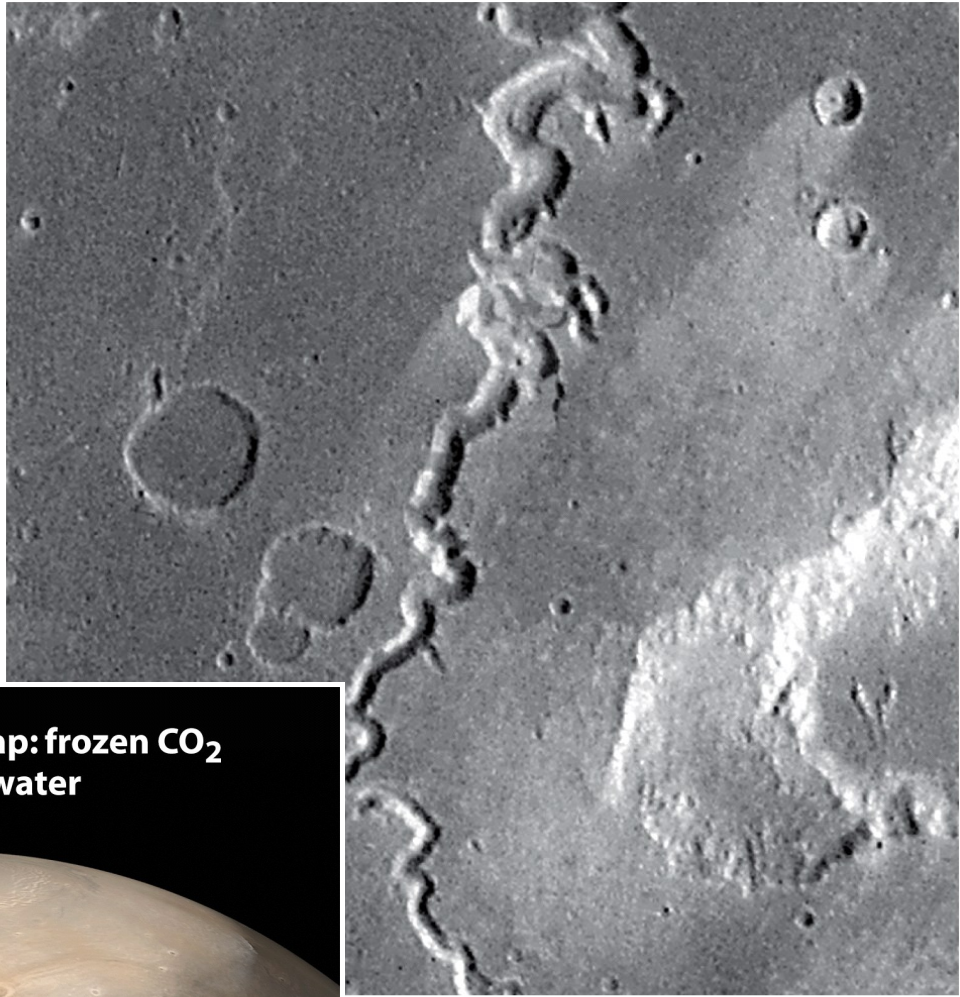


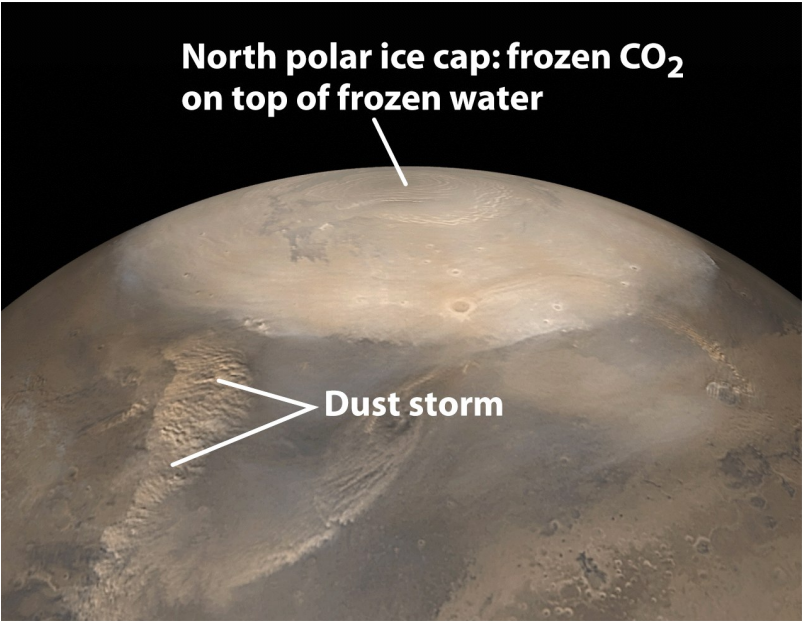
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Ancient Riverbed on Mars



River in China

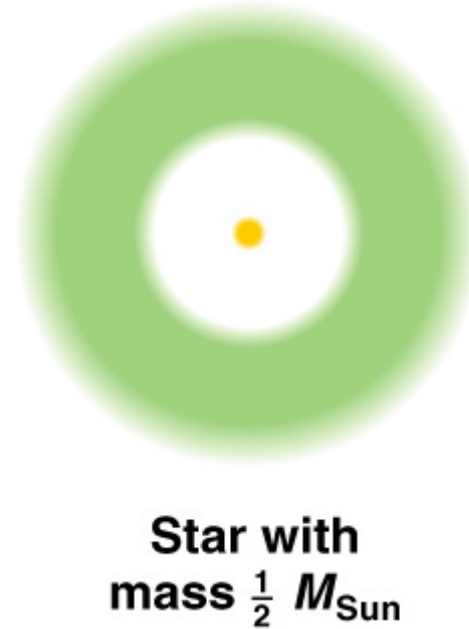
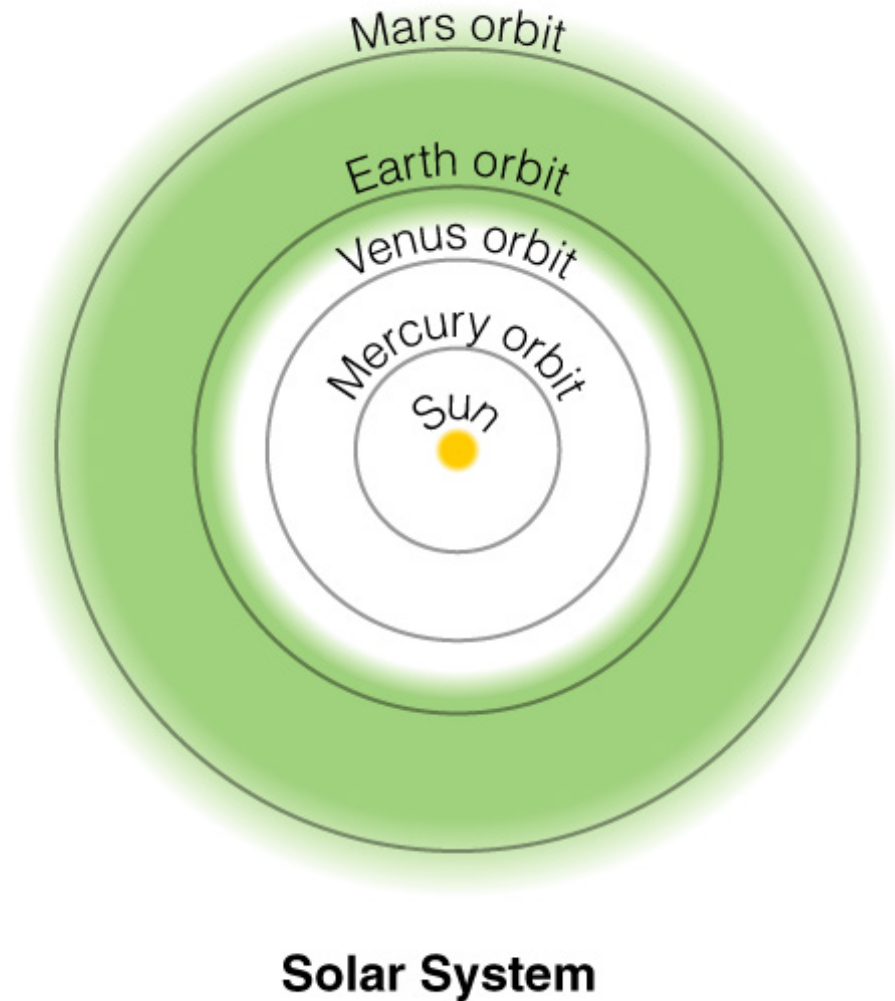


Martian meteorite --- microorganism?



Figure 28-9b
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Are habitable planets likely?



Too close to the center of the Milky Way Galaxy:

- The distances between stars are small, so there can be close encounters between stars that would disrupt a planetary system.
- There are also frequent outbursts of potentially lethal radiation from supernovae and from the supermassive black hole at the very center of the Galaxy.

The Star:

- Must have a mass that is neither too large, or too small.
- If the star's mass is *too large*, it will use up its hydrogen fuel so rapidly that it will burn out before life can evolve on any of its planets.
- If the star's mass is *too small*, the habitable planet would be so close that it would be in synchronous rotation. Water would vaporize on one side and freeze on the other.

The Neighborhood:

- There needs to be one or more large Jovian planets whose gravitational forces will clear away comets and meteors.

Galactic habitable zone

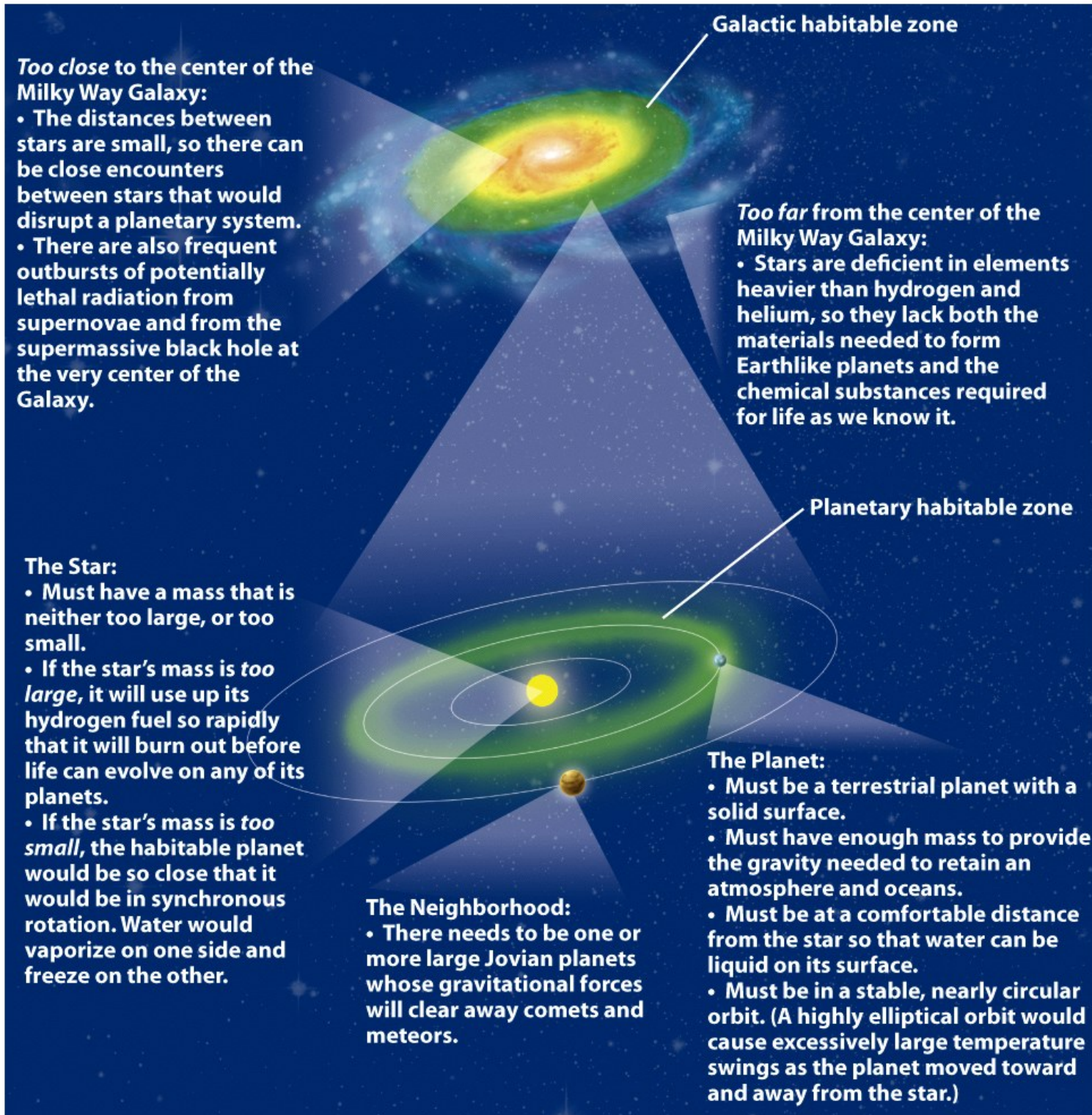
Too far from the center of the Milky Way Galaxy:

- Stars are deficient in elements heavier than hydrogen and helium, so they lack both the materials needed to form Earthlike planets and the chemical substances required for life as we know it.

Planetary habitable zone

The Planet:

- Must be a terrestrial planet with a solid surface.
- Must have enough mass to provide the gravity needed to retain an atmosphere and oceans.
- Must be at a comfortable distance from the star so that water can be liquid on its surface.
- Must be in a stable, nearly circular orbit. (A highly elliptical orbit would cause excessively large temperature swings as the planet moved toward and away from the star.)



Spectrum of a simulated planet

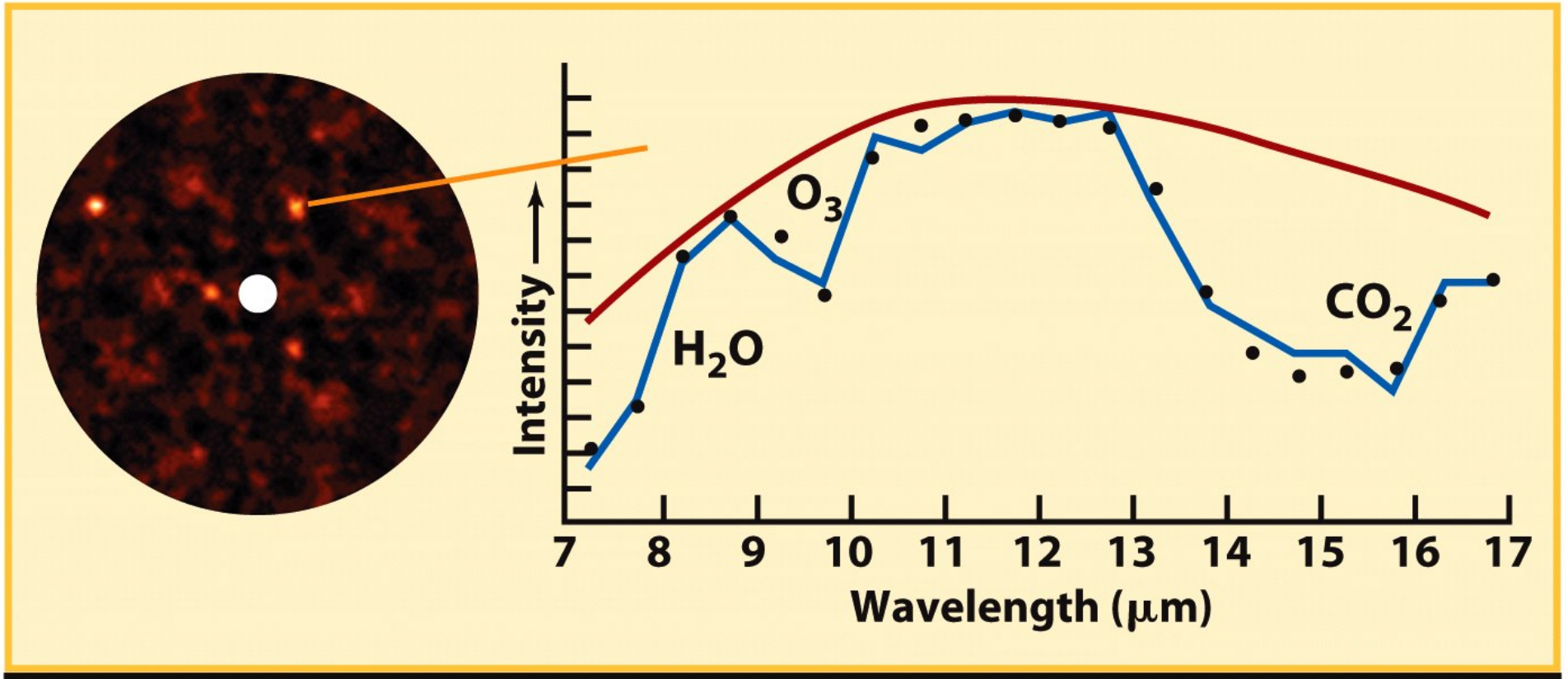


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Terrestrial Planet Finder spacecraft

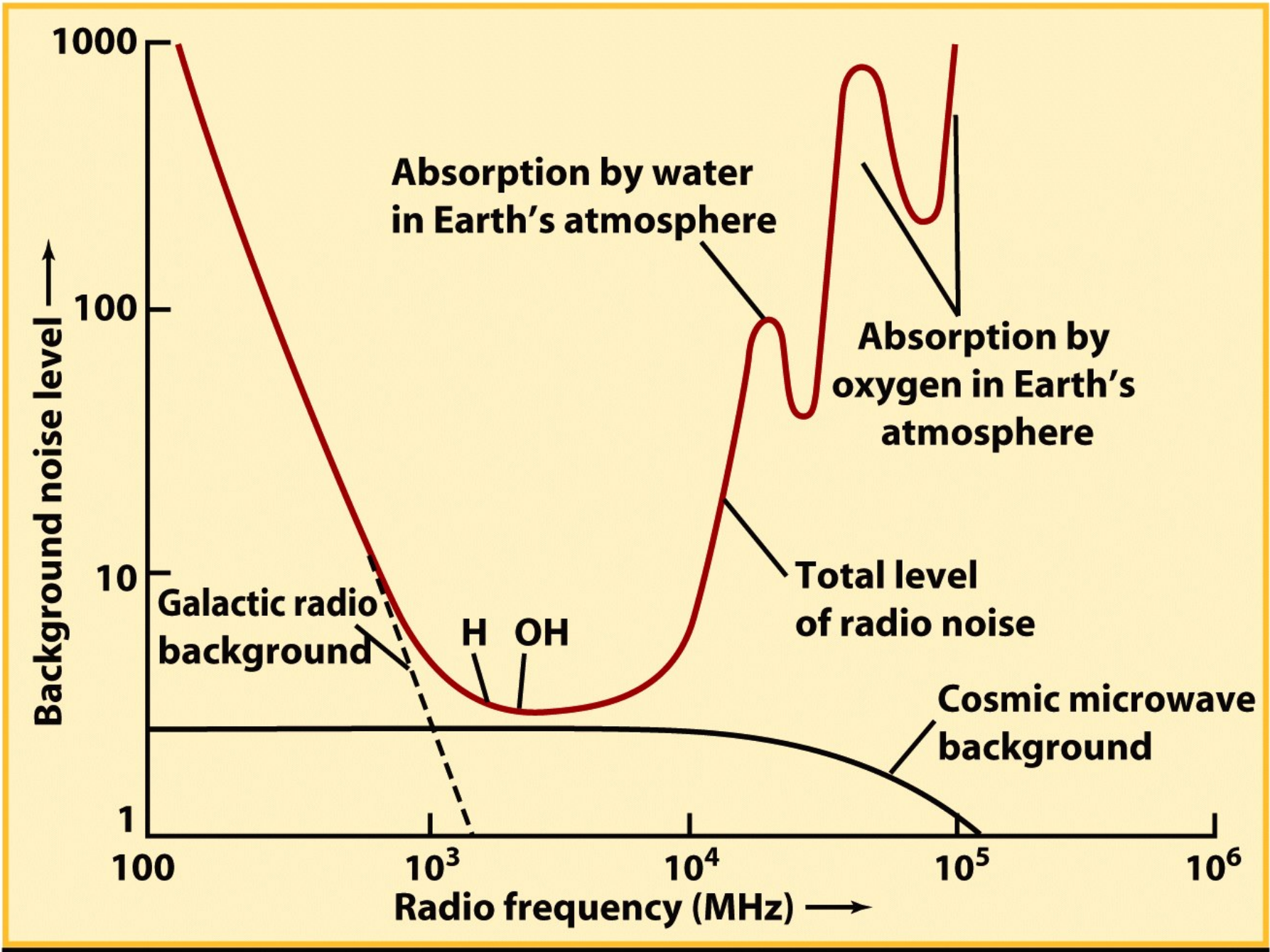


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SETI - Search for extraterrestrial intelligence

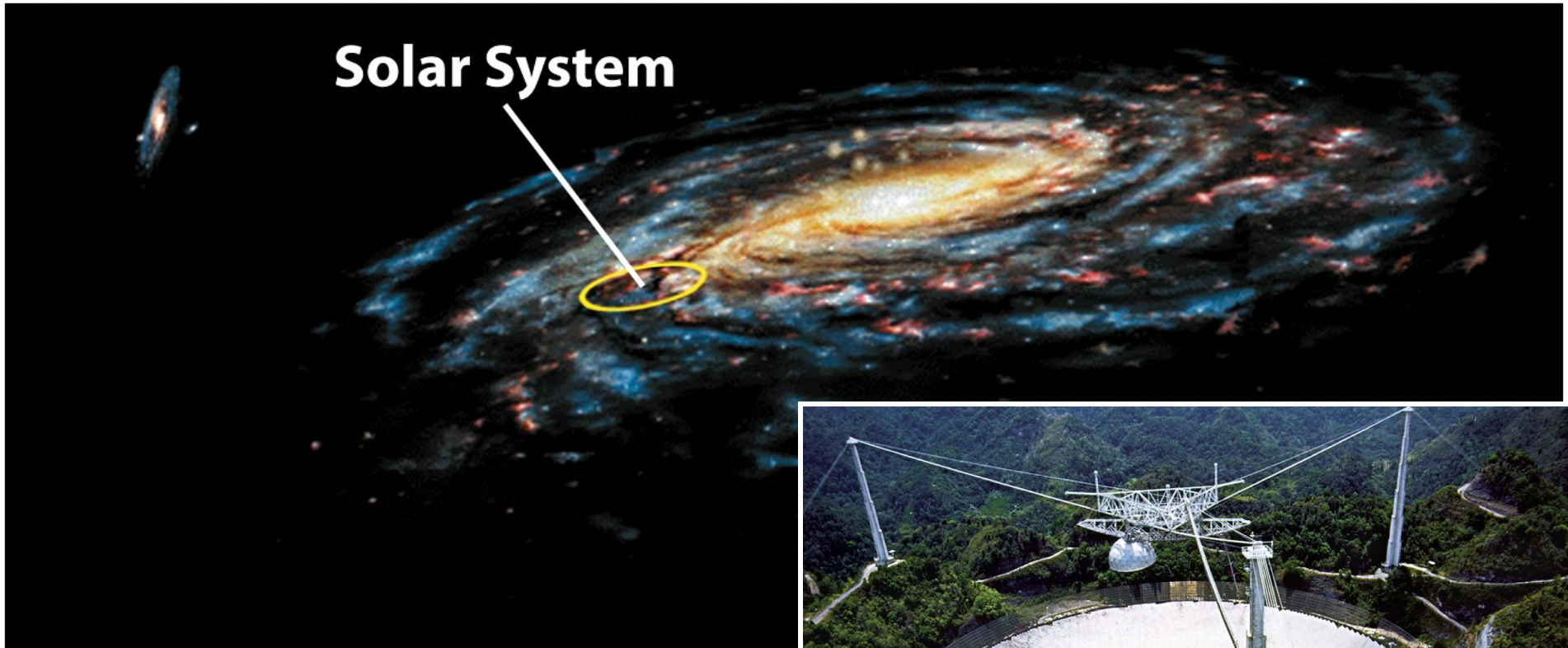


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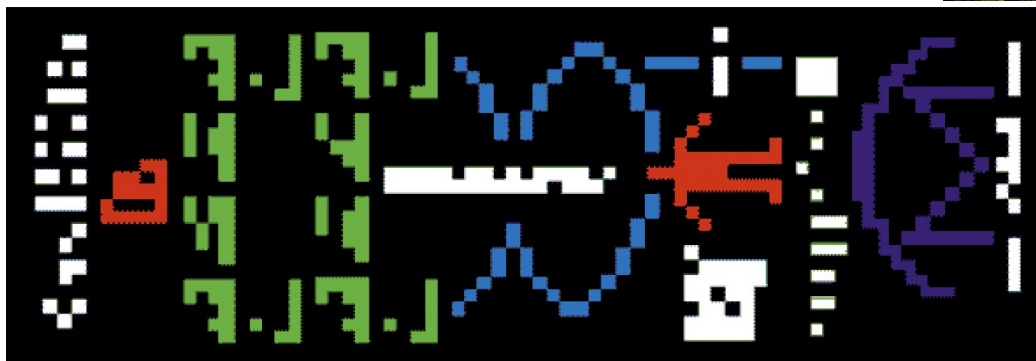
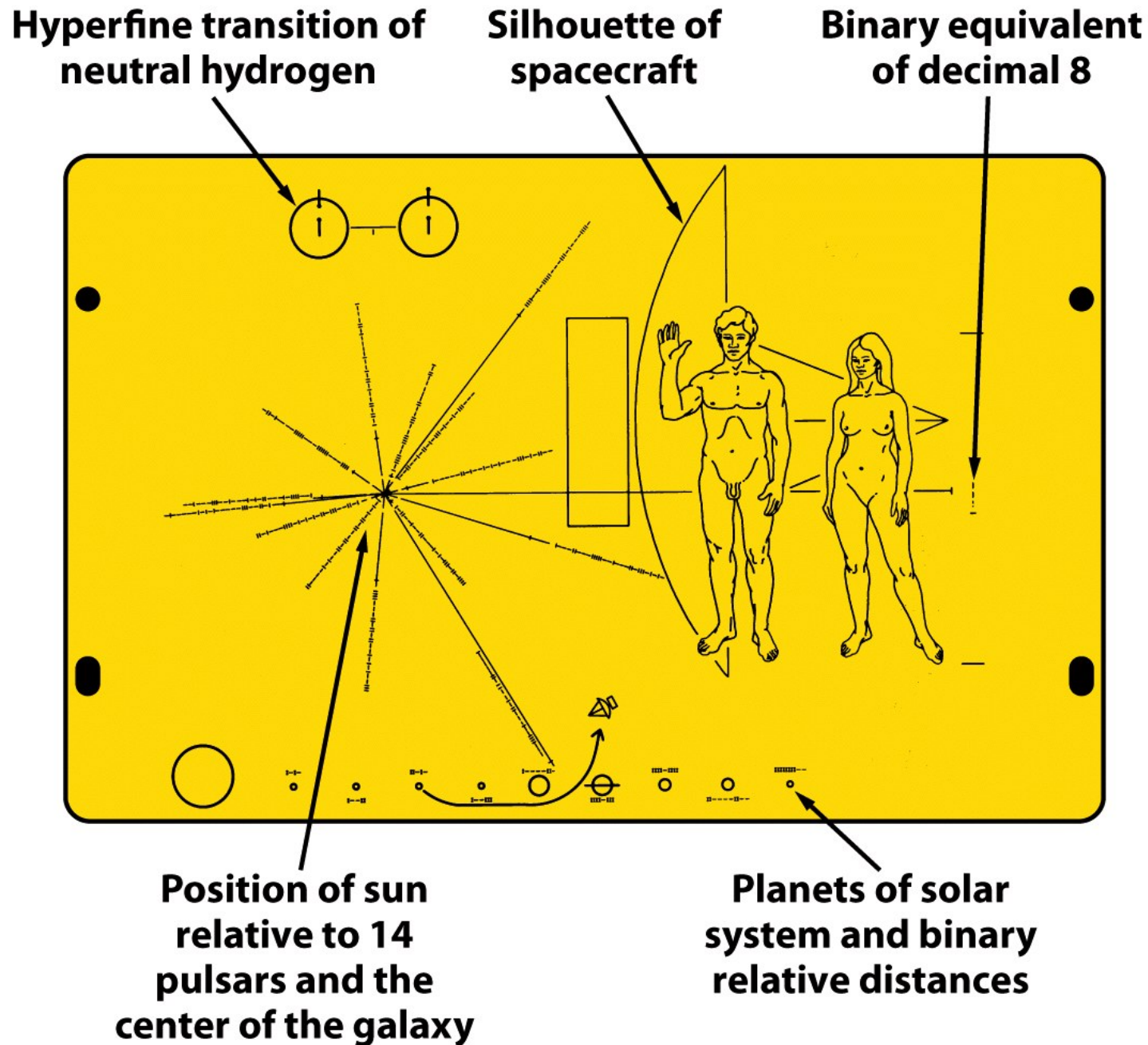


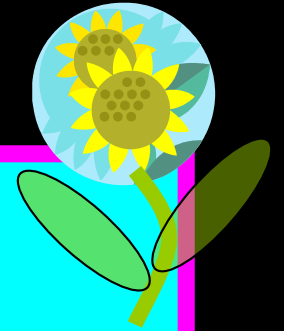
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Plaque on Pioneer 10 spacecraft



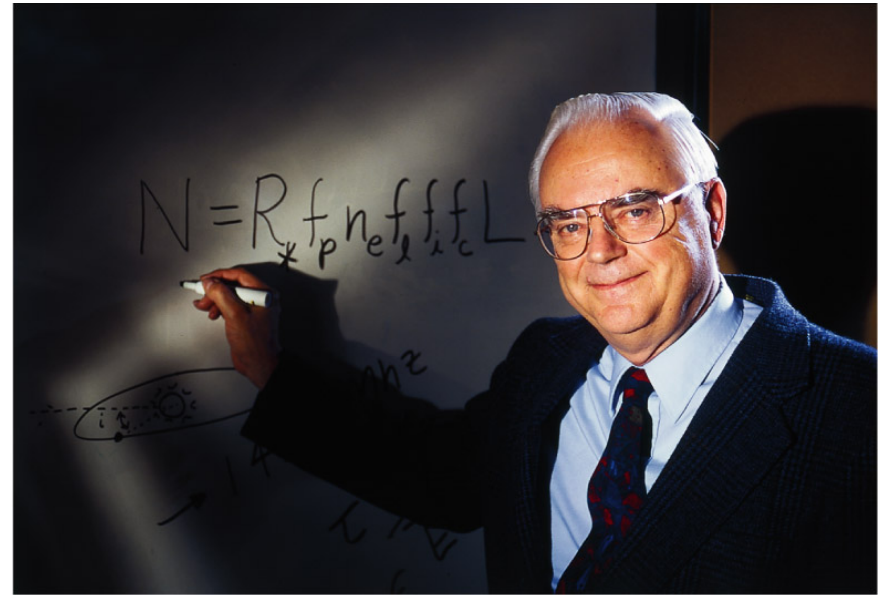
...but, sad as it is....
no response from extraterrestrials yet.

The End



The Drake equation

$$N = R f_p n_e f_l f_i f_c L$$



N : number of technologically advanced civilisations

R : rate at which solar-type stars form in the galaxy

f_p : fraction of solar-type stars that have planets

N_e : number of planets per solar-type star suitable for life

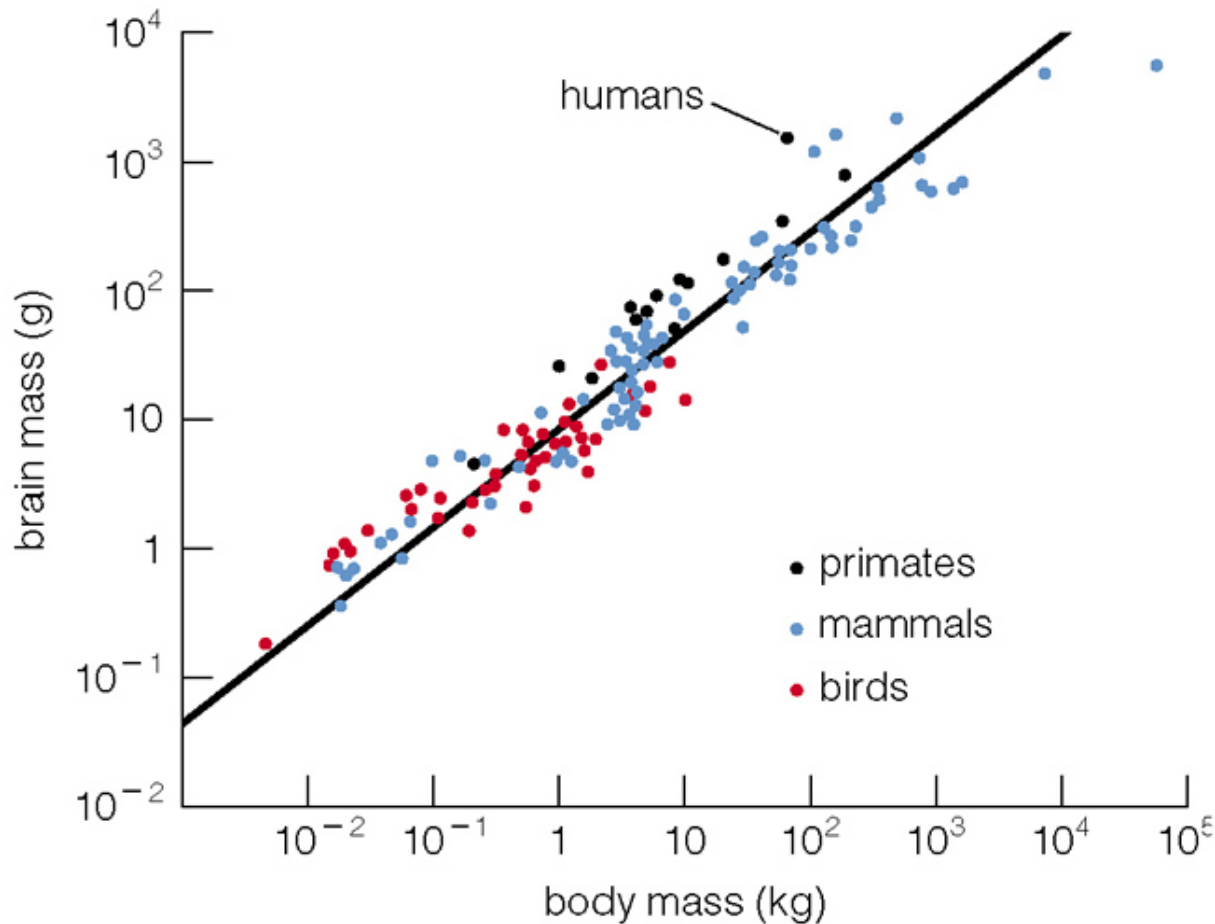
f_l : fraction of such planets with life

f_i : fraction of those lifeforms that evolve into intelligent species

f_c : fraction of those species that send signal to us

L : lifetime of such species

Are we “off the chart” smart?



Humans have comparatively large brains.

Does that mean our level of intelligence is improbably high?

Evidence of ancient Martian water

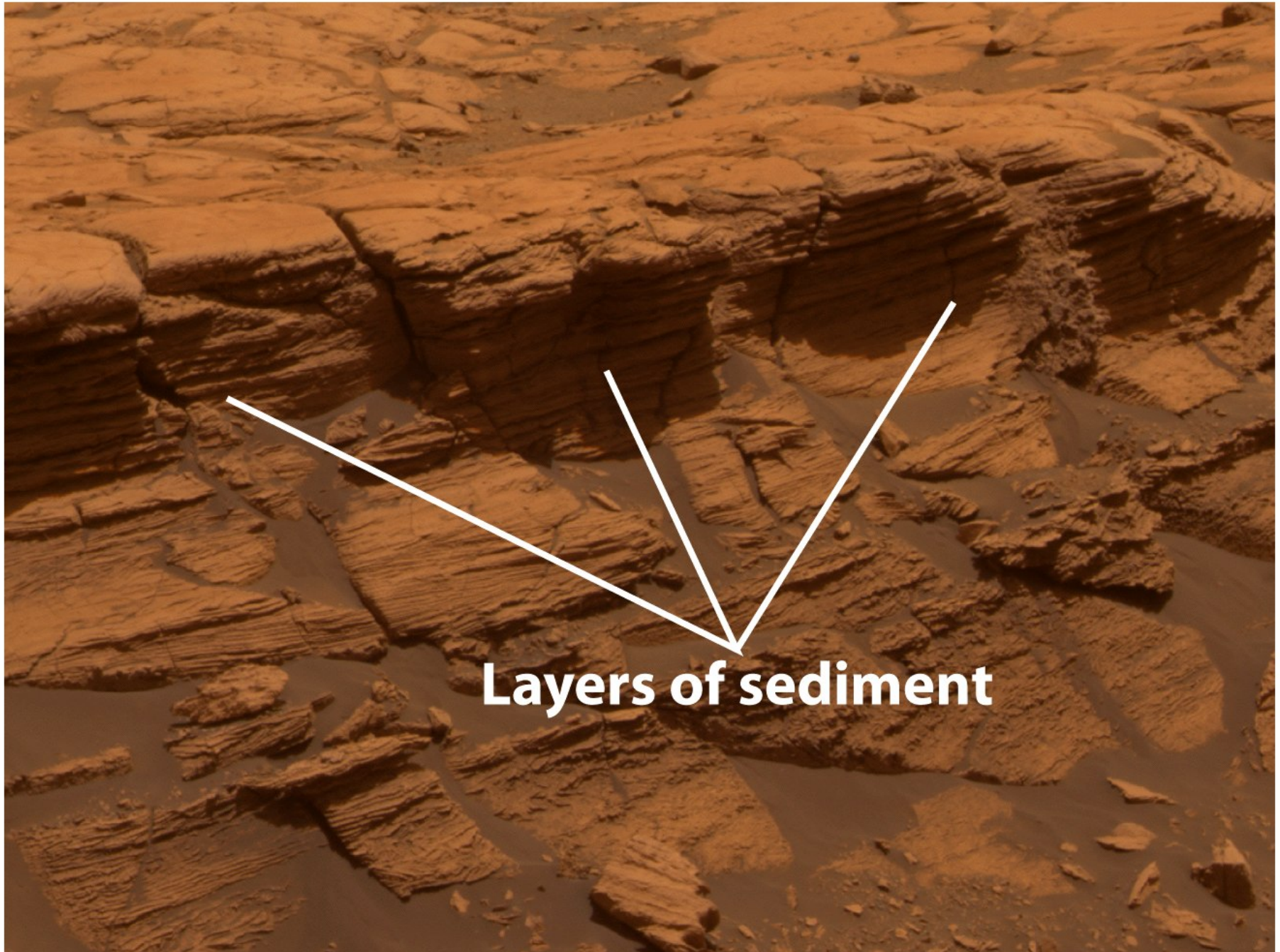


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