Uninhabited (Vacant) Habitats on Mars

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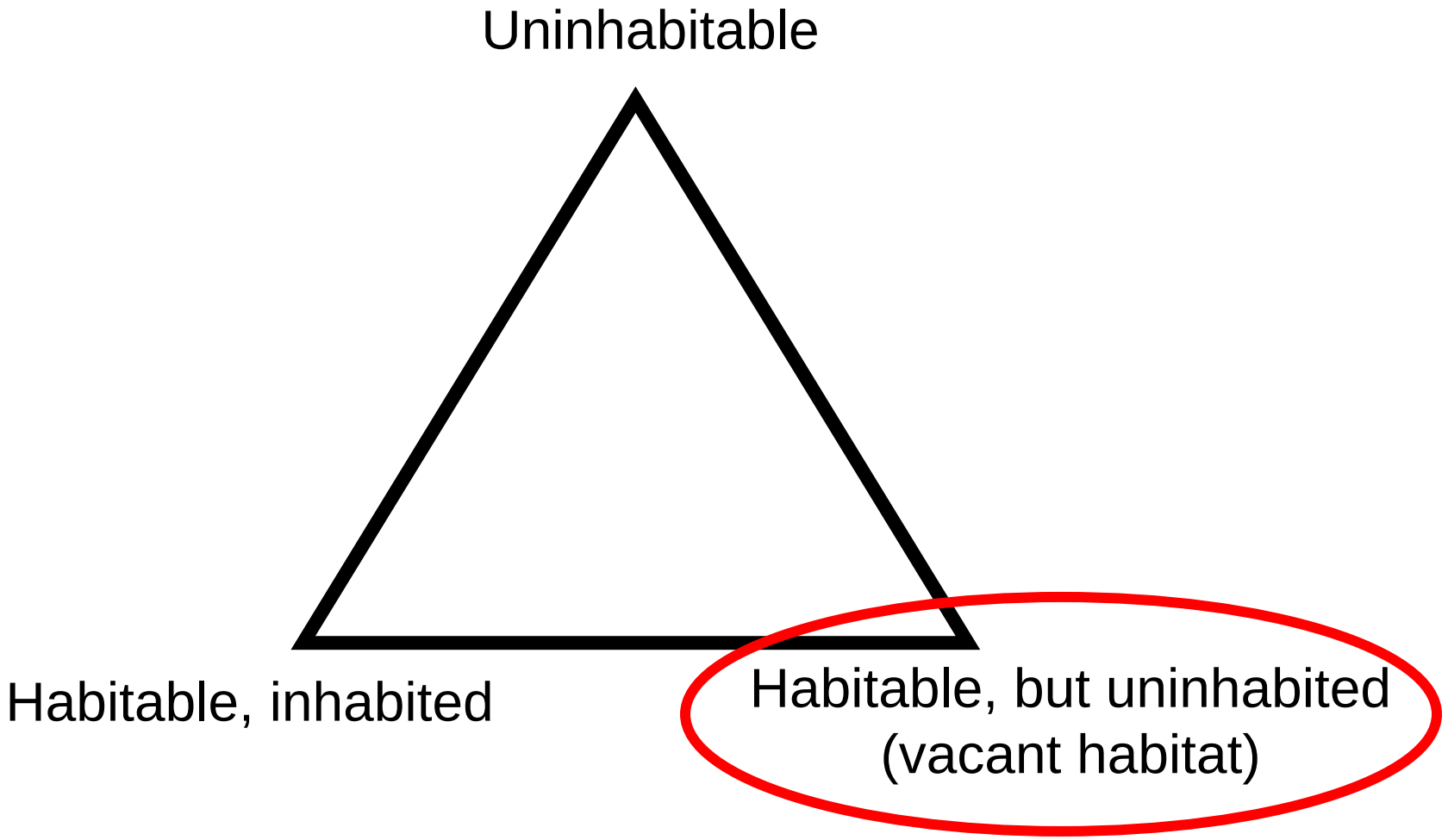
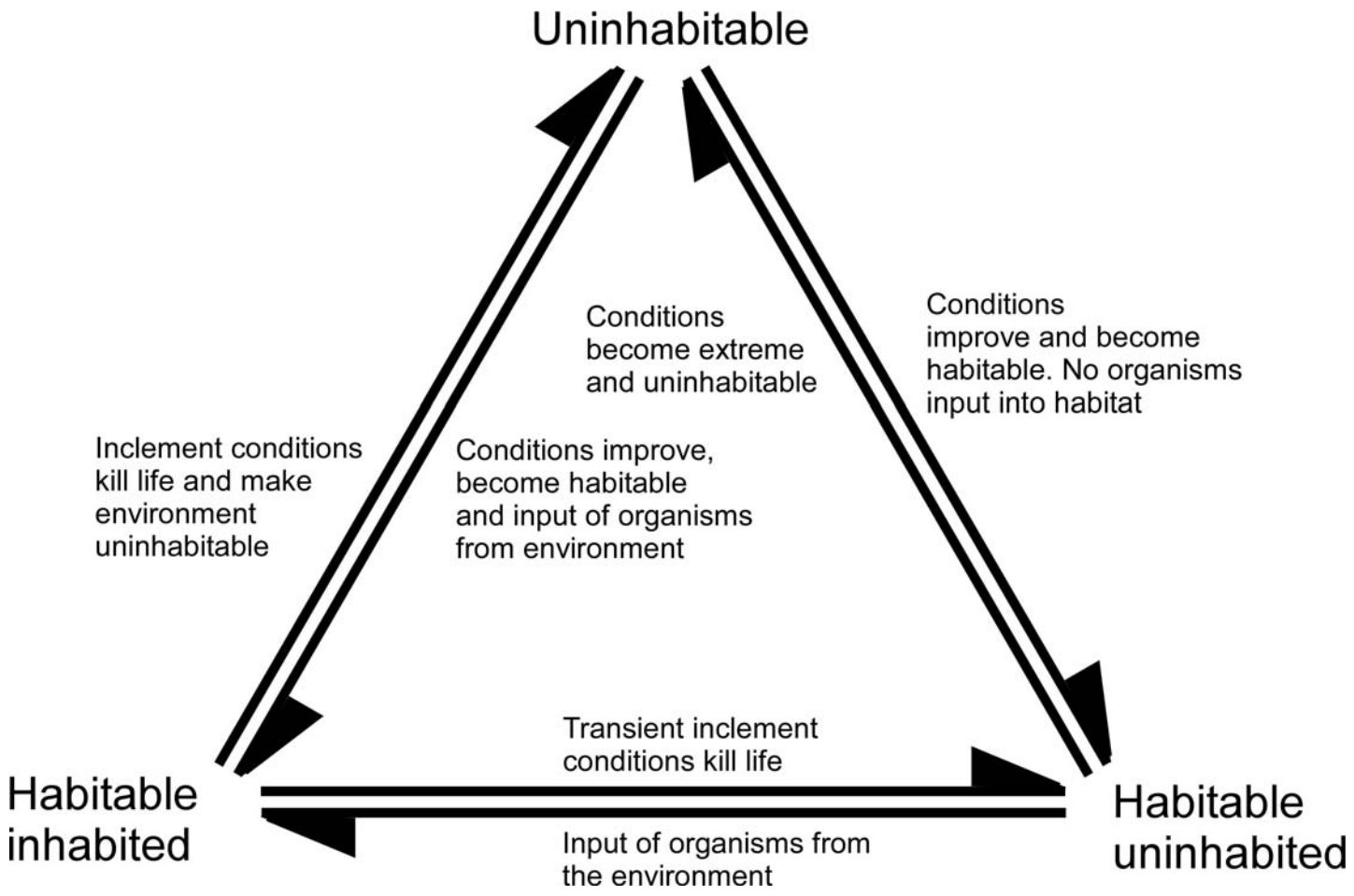
All environments in the universe can be binned into one of three categories:

A‘Habitability Triad’



Cockell CS (2011) Vacant habitats in the Universe. *Trends Ecol. Evol.* **26**, 73-80
Cockell CS, Balme M, Bridges J, Davila A, Schwenzer S (2011) Uninhabited habitats on Mars. *Icarus* (in review)

Habitability Triad



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Why are uninhabited habitats so rare or transient on the Earth?

1.Vast quantities of organic carbon (1 x 10^{16} mol C yr^{-1}) and oxygen produced by photosynthesis contaminate almost any habitat, even very transient water bodies in extreme polar environments

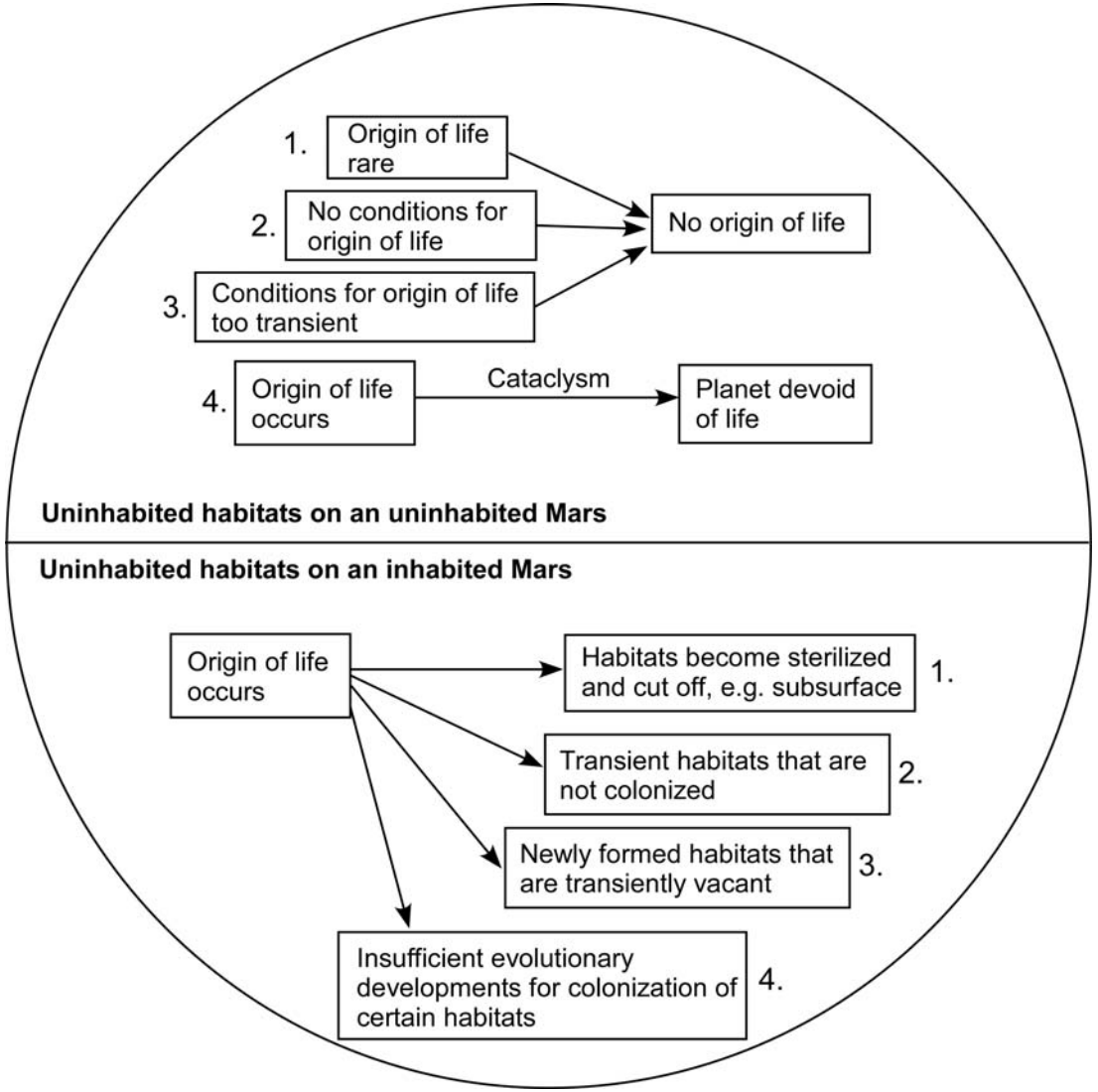
2.Widespread hydrological cycle facilitates transfer of photosynthetic products and microorganisms from one habitat to another.

3. Atmosphere is generally clement for microbial transfer from one habitat to another.

- **These factors explain the lack of study of uninhabited habitats.**

<u>On Mars these conditions are not met to the same extent, if at all.</u>

A categorisation of uninhabited habitats on Mars



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Two categories of uninhabited habitat:

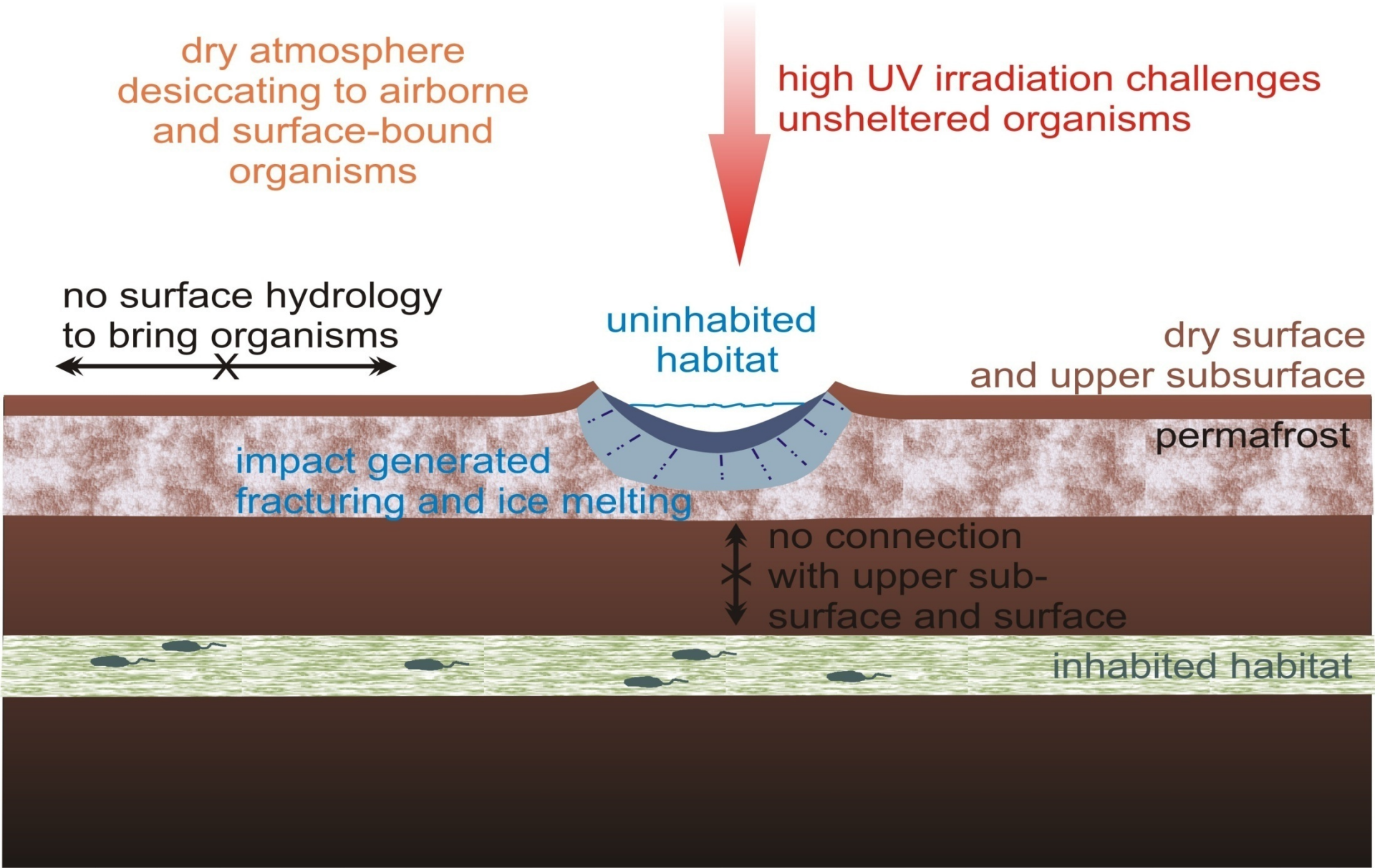
1.Uninhabited habitats on an uninhabited planet.

- **Would result from the lack of an origin of life, but the presence of habitable conditions**

2. Uninhabited habitats on an inhabited planet.

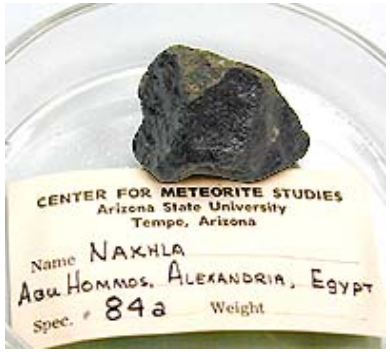
- **Would result from a lack of transfer mechanisms for life into newly created or newly sterilized habitats or lack of appropriately evolved biochemistries.**

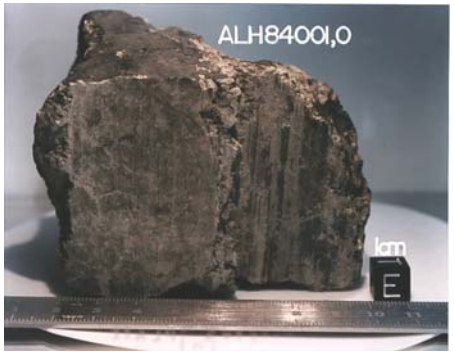
A plausible scenario for an uninhabited habitat on the surface of an inhabited Mars



How do we test the hypothesis, 'Where there are habitats there is life'?

- Look in Martian meteorites on the Earth.



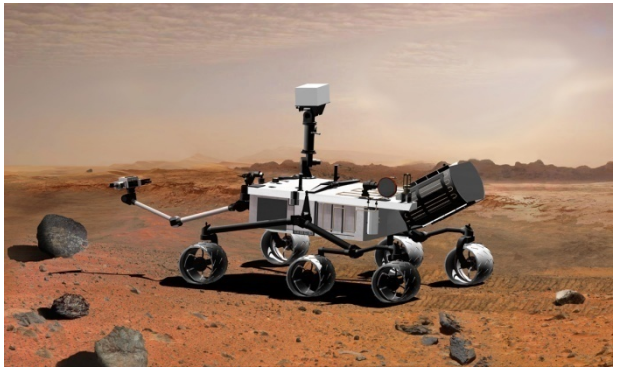


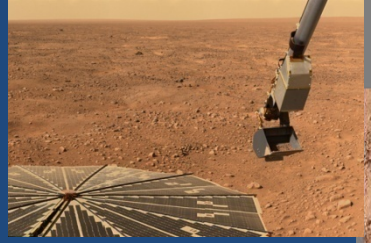
Null hypothesis: these are fragments of rock from uninhabited habitats

- Look *in situ*.

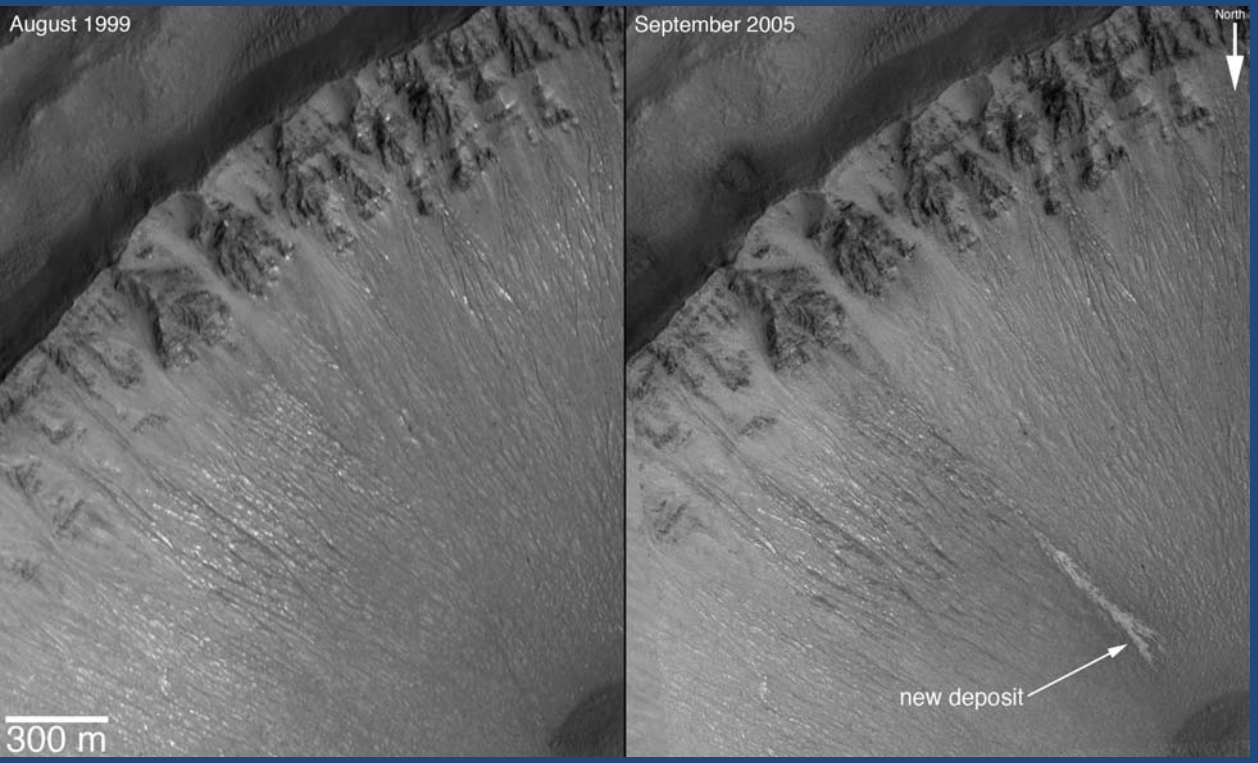
An uninhabited habitat should exhibit two characteristics:

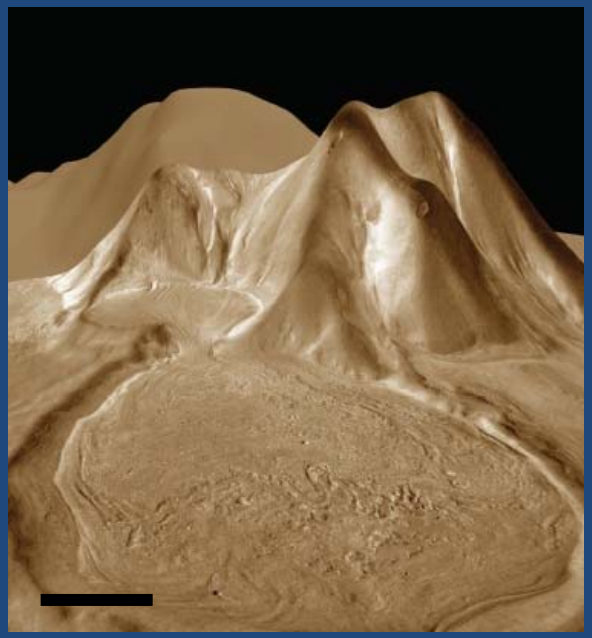
1. Have conditions that are habitable (i.e. energy, required elements, water, etc.)
2. Does not contain organics associated with life (but may contain meteoritic organics).

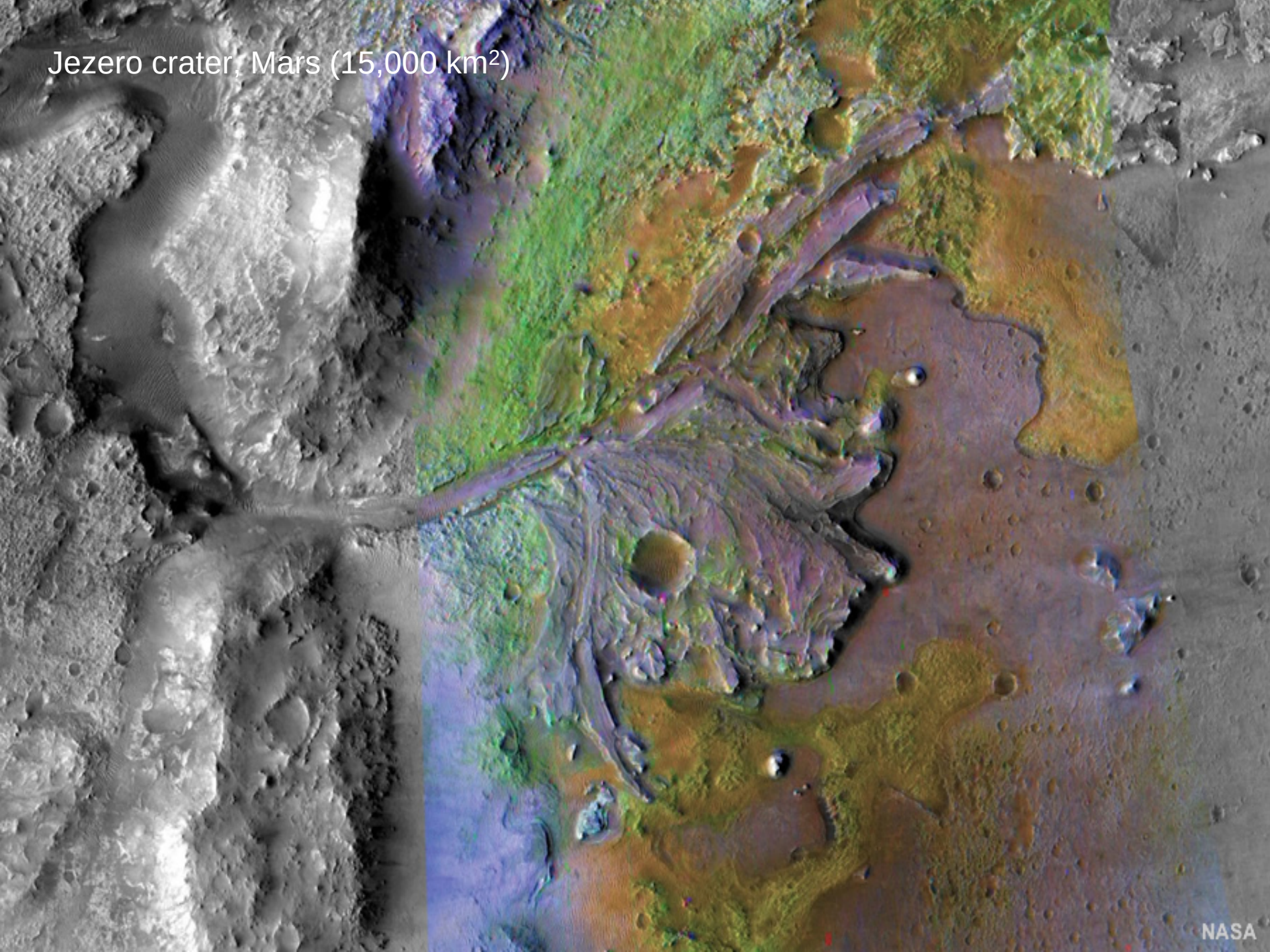





Sol 20
Sol 24
2/3"
2/3"


August 1999
September 2005
North
new deposit
300 m




Jezero crater, Mars (15,000 km^2)
NASA

What is the significance of uninhabited habitats?

- **Broad significance for astrobiology: In addressing the 'where there are habitats, there is life' hypothesis we define new conditions of habitable space that are rare on the Earth, but might be much more common elsewhere.**

- **Importance for terrestrial biogeochemistry. They would provide us with habitable, but lifeless control environments to answer questions about the role of life in Earth system processes: untangle the biotic and abiotic contribution to elemental cycling. Significant for understanding elemental cycling on the early Earth.**

Summary

- **Uninhabited habitats may be common in the Universe.**

- **They may exist on Mars. We can directly test for their presence. MSL and future craft/sample return may come across them.**

- **Importance for terrestrial biogeochemistry and an understanding of what limits the distribution of life in the Universe.**

- **Planetary Protection: Should we contaminate extant uninhabited habitats?**