Planetary Protection

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Planetary Protection History

- Questions of life—the fate of life on Earth and the possibility of life elsewhere—have driven space exploration from its beginnings. Thus, planetary protection has been a concern from the start of the Space Age.

  How can we make the observations required to understand the origins, distribution, and destiny of life in the universe:

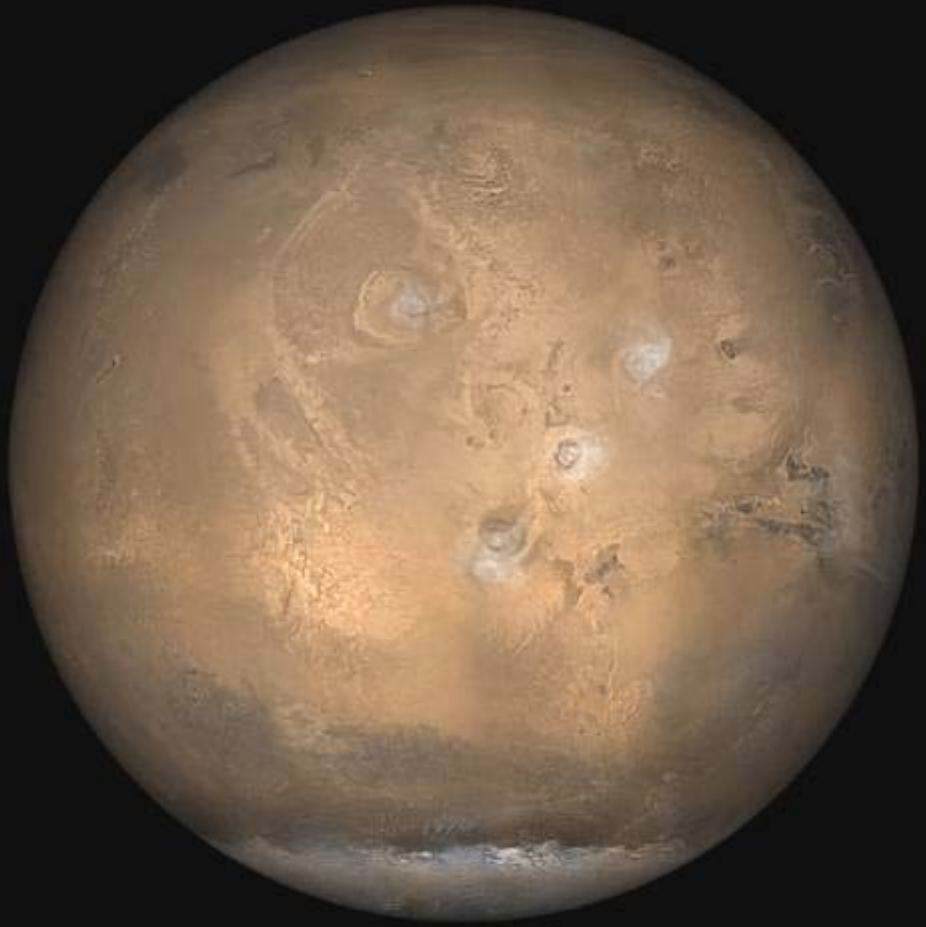
  - Without destroying or contaminating the evidence required?
  - Without changing the distribution and/or destiny of Earth or alien life?

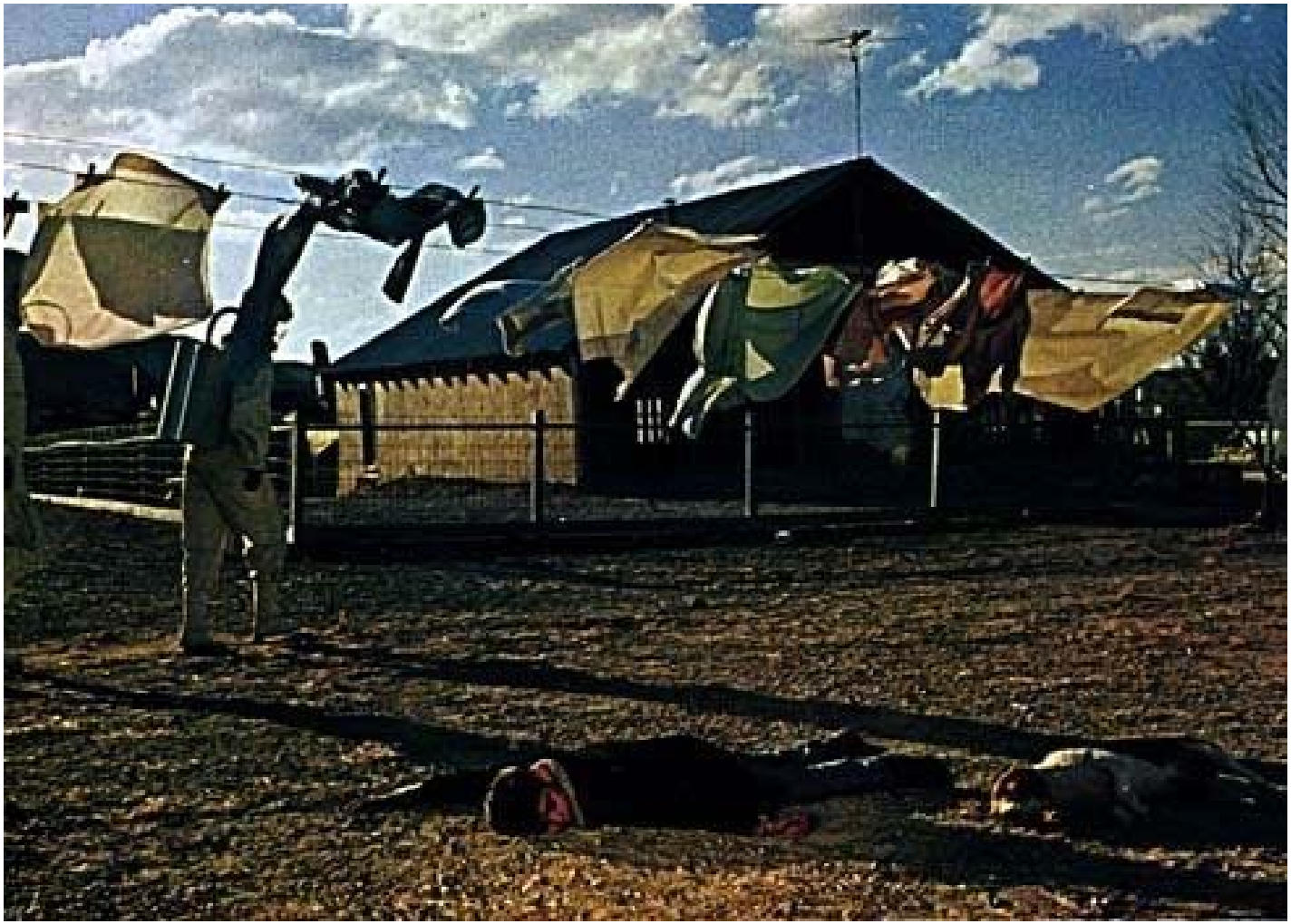
Basic Planetary Protection Policy

- Preserve planetary conditions for future biological and organic constituent exploration
  - avoid **forward contamination**; preserve our investment in scientific exploration
- To protect Earth and its biosphere from potential extraterrestrial sources of contamination
  - avoid **backward contamination**; provide for safe solar-system exploration

The UN Space Treaty of 1967

- Article IX (part)
  - "States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose."





Science & Technology
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Earth's Deep-Sea Hydrothermal Vents: Life-as-we-didn't know it...

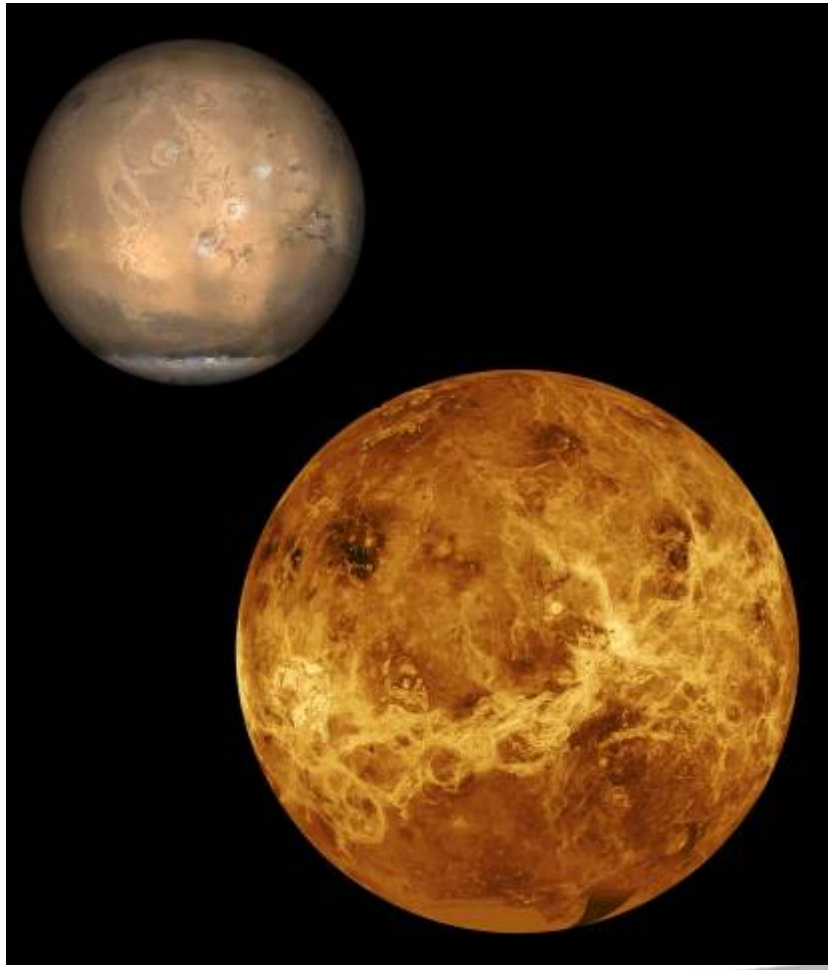
The discovery of abundant life at deep-sea hydro-thermal vents in 1977 (7 months after the Viking missions landed on Mars) surprised everybody!

- It isn't that we expect to find these things out there –
- It's that we never expected to find them *here*....

Planetary Protection: Evolving Requirements

Planetary protection evolves as the planetary exploration program progresses and as advances in planetary science—access, knowledge, measurement technologies...

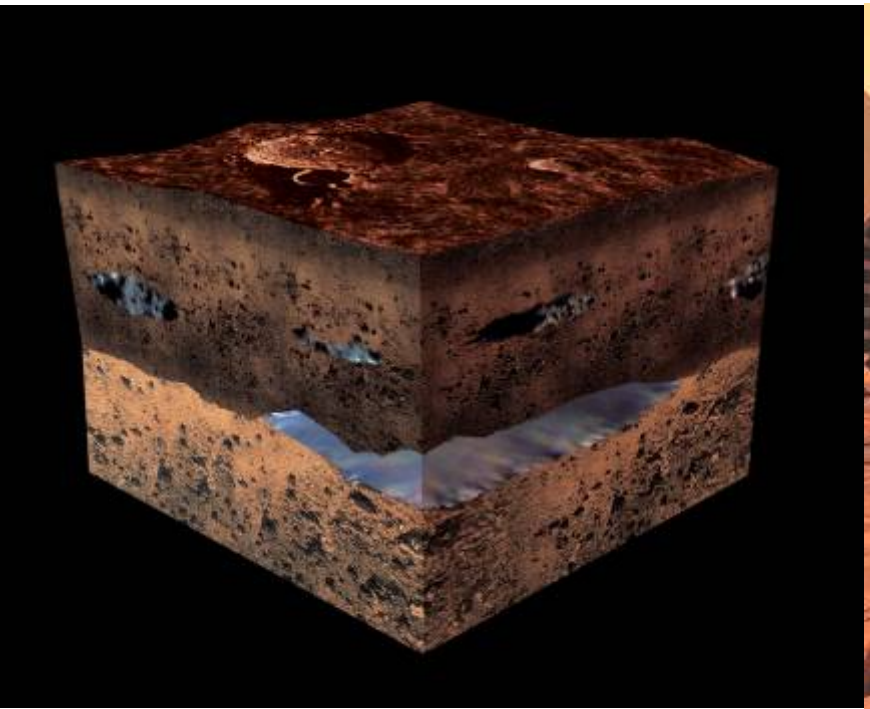
... so we seek regular external and internal advice on what is required to implement the policy.



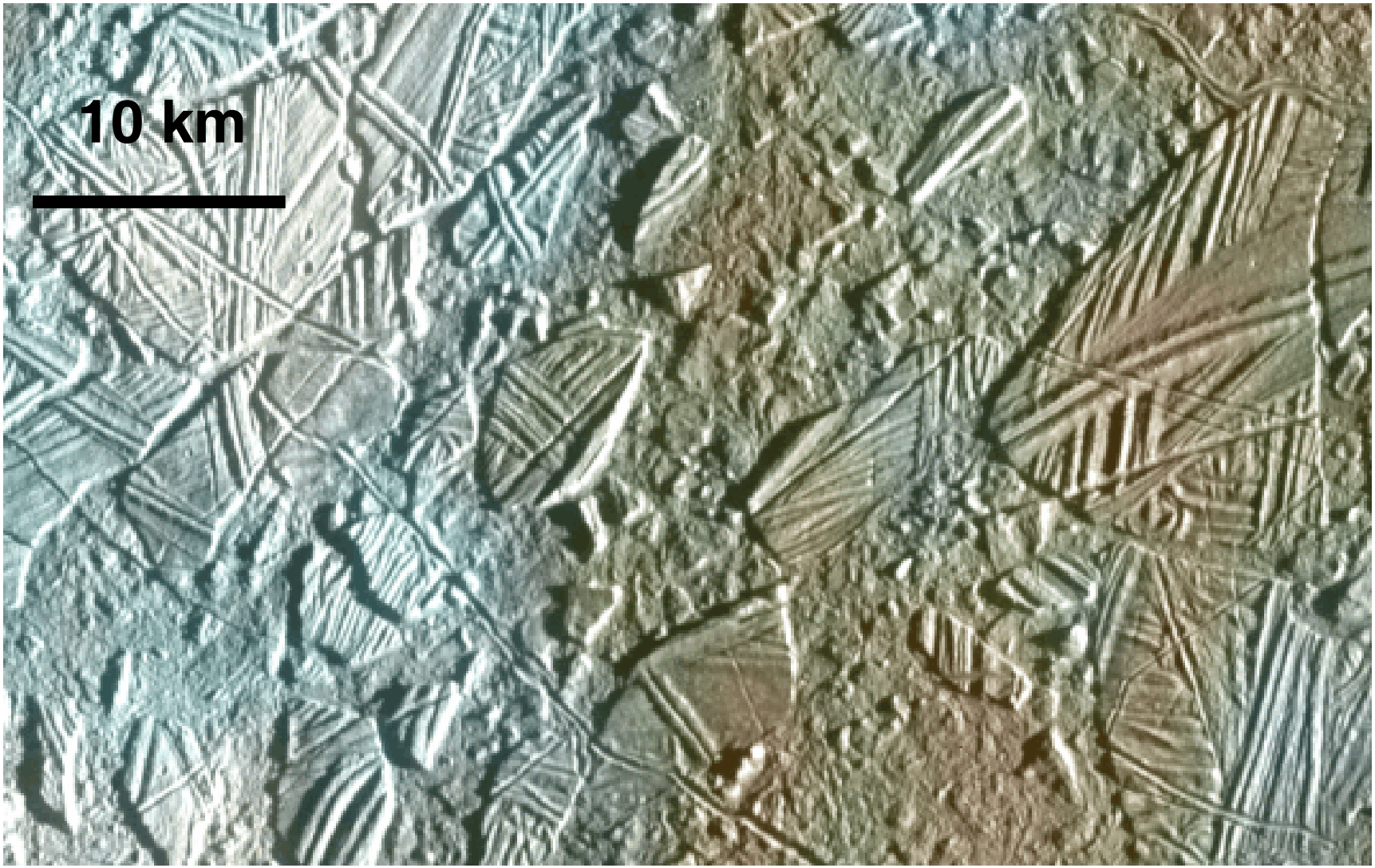
Total surface bioburden of no more than 3 x 10^5 aerobic bacterial spores (NSM), an average of no more than 300 spores per square meter, and total bioburden (surface, mated, and encapsulated for launch) of ≤ 5 x 10^5 spores

Humans on Mars?

- Human capabilities may be required to explore deep subsurface aquifers, if they exist beneath the Martian deserts
- Requires a preliminary robotic search for life, because of the potential for human-associated contamination: both forward and backward

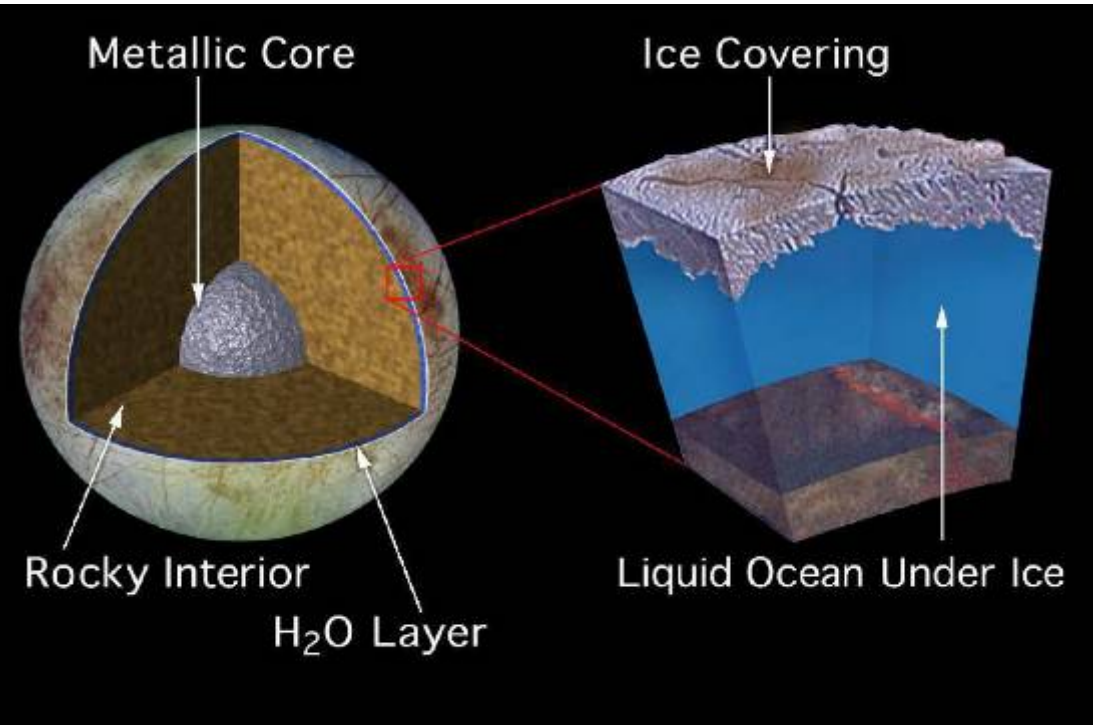


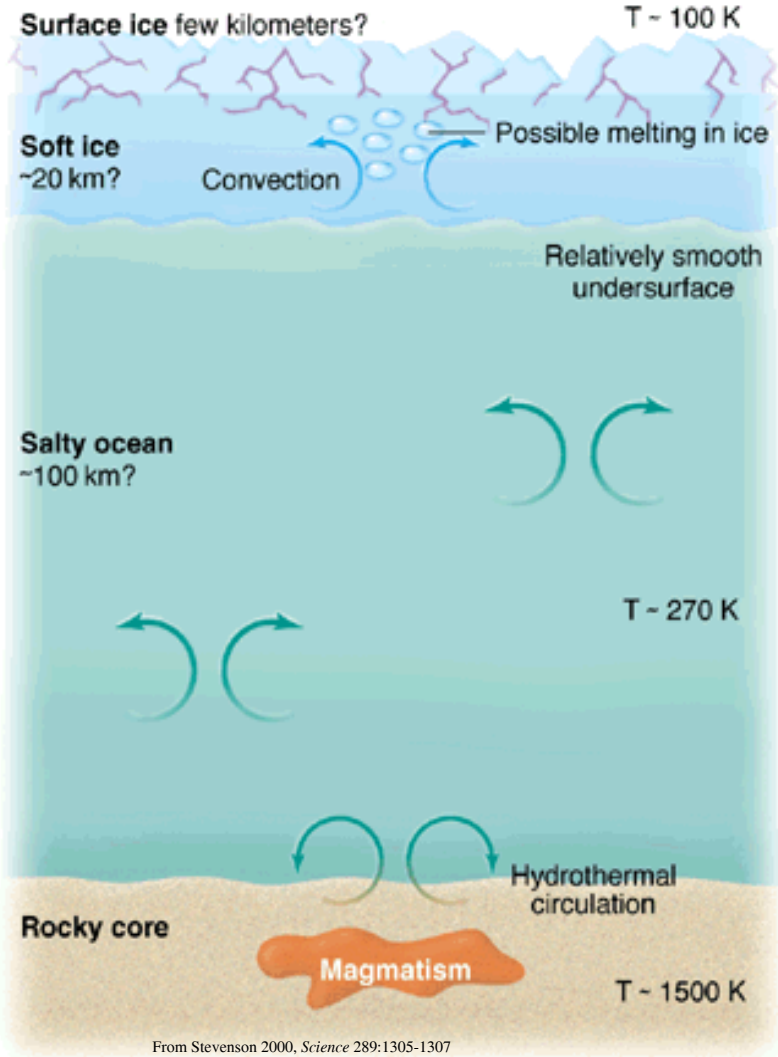
What is Europa's Ocean Like?



Chaos regions and "ice rafts" suggest melting and disruption of the surface

Europa—Focus of Future Astrobiological Study



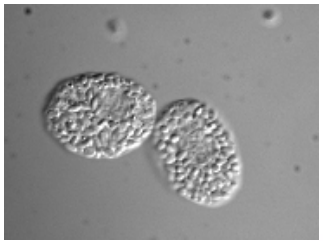


From Stevenson 2000, *Science* 289:1305-1307

Hydrothermal Vents?

Current Issues in Forward/Backward Contamination Control

- Understand microbial biodiversity of cleanroom environments
- Understand survival of Earth organisms under the range of conditions that may be experienced on Mars, Europa, etc.
- Better understand the location/extent of Mars environments that may be capable of supporting Earth life
- Develop encapsulation technologies
- Establish Fail-Safe methods to break chain between target bodies & Earth



- Develop and qualify new methods for the monitoring of microbial contamination on spacecraft
- Develop and qualify new methods for removing biological contamination from Mars spacecraft (embedded bioburden)

Images, Courtesy NASA