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."

COSPAR's Policy Categorization(s)

- Five categories of planetary protection defined by the nature of the mission to be launched and nature and understanding of the target body to be studied or encountered

COSPAR's Policy Categorization(s)

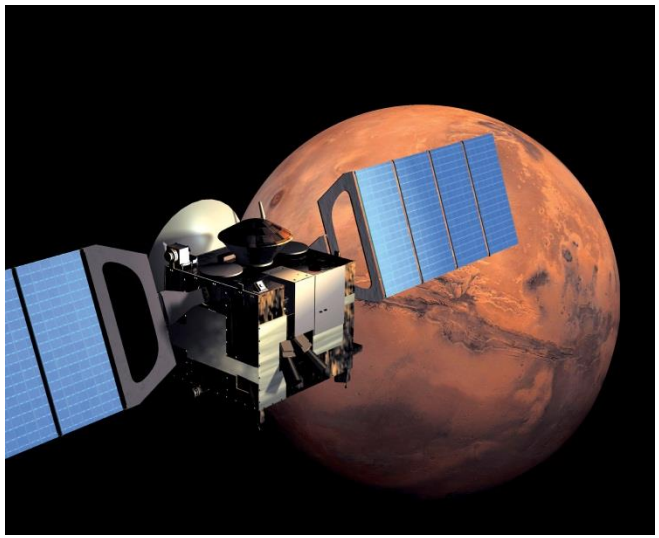
- Category I missions—No planetary protection procedures required for missions to bodies not of interest to the study of chemical evolution and the origin of life

COSPAR's Policy Categorization(s)

- Category II missions are those for which the target body is of interest to researchers studying organic chemical evolution and the origin of life, but where biological contamination is not thought to be possible
    - » Document spacecraft trajectories, inventory onboard organic materials, and possibly provide for the archival storage of certain spacecraft materials

COSPAR's Policy Categorization(s)

- Category III missions that fly-by or orbit planets that could be contaminated by Earth organisms
  - » Category II plus other restrictions, such as cleanroom assembly procedures and orbital lifetime restrictions

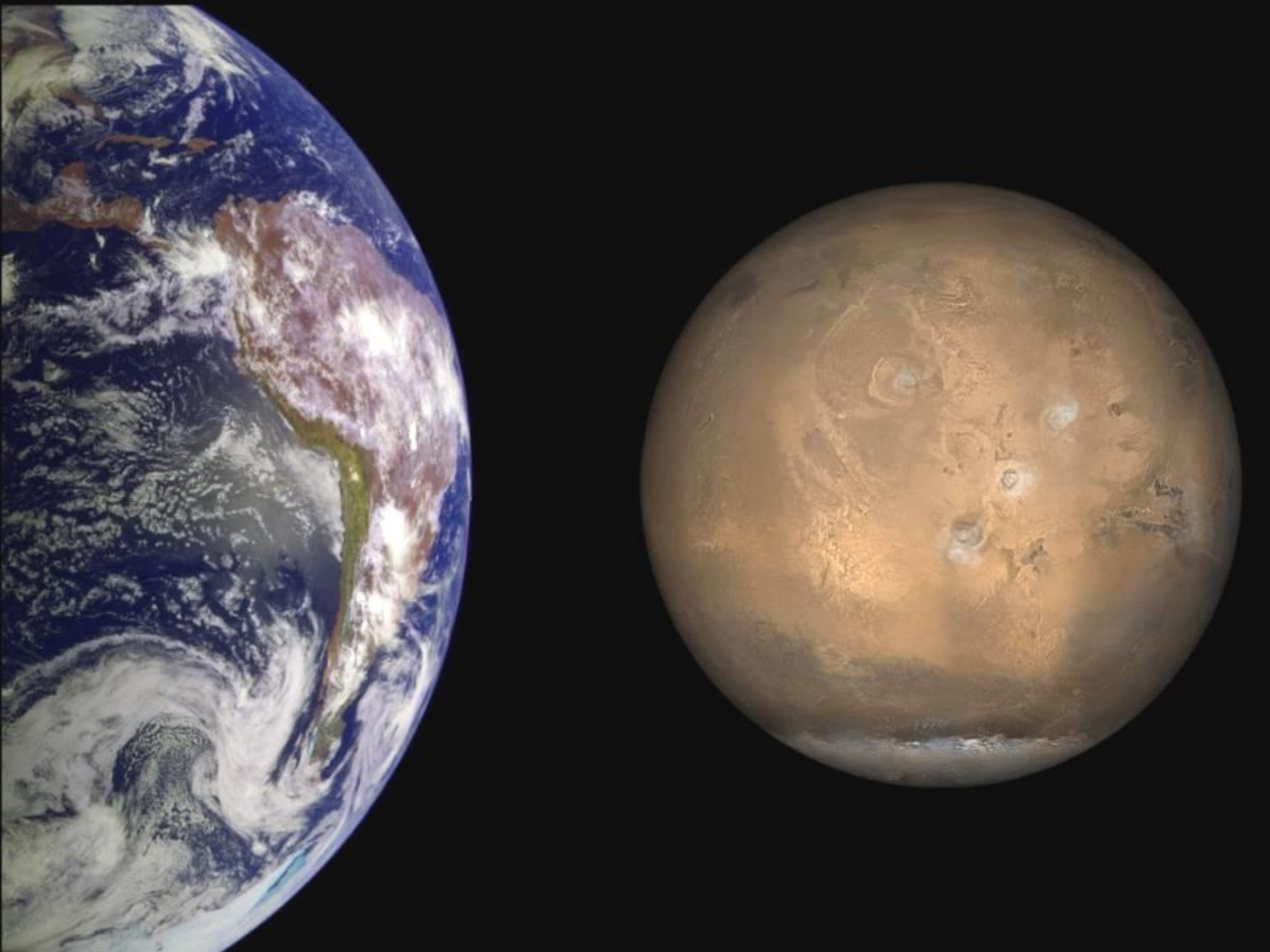


COSPAR's Policy Categorization(s)

- Category IV missions are landers to bodies that may be contaminated
  - » Category II and III requirements apply (except for orbital lifetime)
  - » Restrictions on biological contamination are generally more severe, and may include comprehensive decontamination and sterilization of the spacecraft
  - » A probability of contamination calculation is required for such missions

COSPAR's Policy Categorization(s)

- Earth-return missions are placed in Category V, regardless of the outbound category
  - » "Unrestricted Earth return," with no additional planetary protection requirements on the return portion of the mission
  - » "Restricted Earth return" missions, with all Category II, III, and IV restrictions plus strict controls on the handling of returned samples until their biological status is determined.



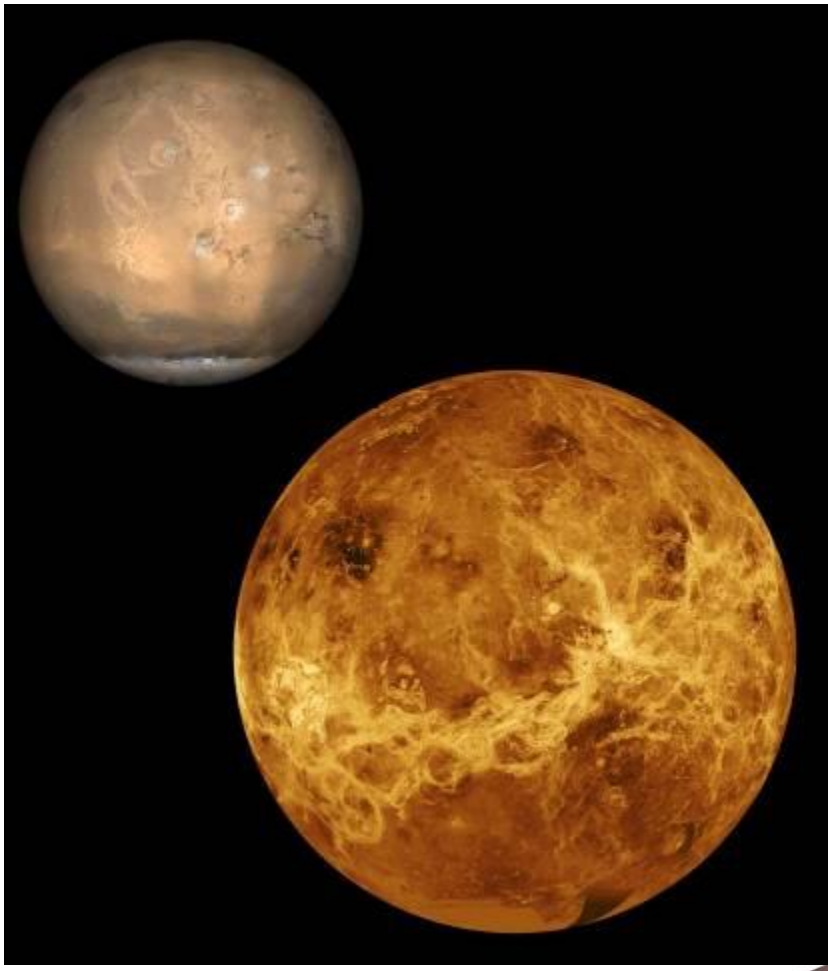
Earth's Deep-Sea Hydrothermal Vents: Life-as-we-didn't know it...

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*....

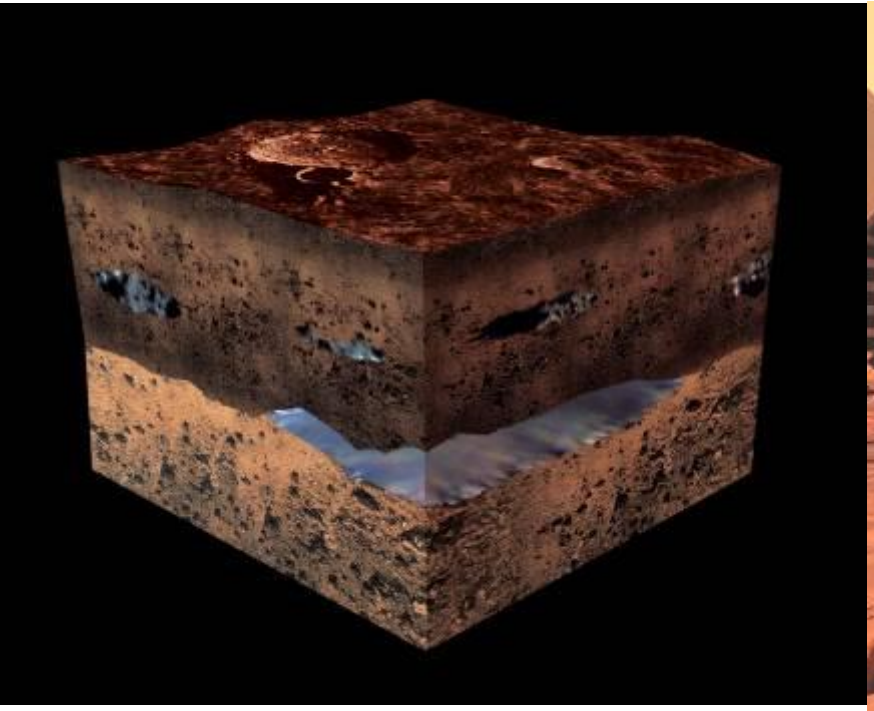
Planetary Protection: Evolving Requirements

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



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



Current Issues in Forward 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, and keep track of them using a comprehensive database

- 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