# Introduction to planetary protection and expectations from review

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# What planetary protection is not

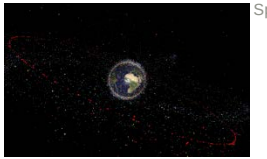
It is not about asteroid defense

→ Covered in the Near Earth Objects (NEO) and Space Situational Awareness (SSA) programs

Fireball exploded above Chelyabinsk city in the morning of 15 Feb. 2013

It is not about space debris

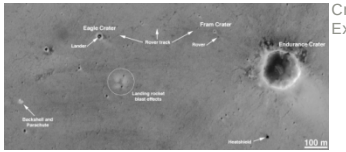
→ Covered in the Space Surveillance and Tracking (SST), space debris, and sustainability programs



Space Debris Image: ESA

It is not about cultural or natural world heritage

→ Covered by UNESCO based on a convention (for Earth) and the COSPAR Panel on Exploration (for space)




Credit: NASA/Mars Exploration Rover

Credit: Mars Daily

It is not a green party for space

It is not about playing around with guns and ET

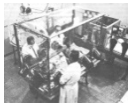

Credit: Sony Pictures

# History of planetary protection

"…we are in the awkward situation of being able to spoil certain possibilities for scientific investigations for a considerable interval before we can constructively realize them…we urgently need to give some thought to the conservative measures needed to protect future scientific objectives on the moon and the planets…" J. Lederberg and D. B. Cowie, *Science*, 1958

- → Reflects the concern raised by the International Astronautical Federation (IAF), UN-COPUOS and US National Academy of Science (NAS) in this time period that lead to the Committee on Contamination by Extraterrestrial Exploration (CETEX), established by the International Council of Scientific Unions (ICSU)
- → ICSU adopts the CETEX Code-of-Conduct and established the Committee on Space Research (COSPAR)
- → COSPAR established the Consultative Group on Potentially Harmful Effects of Space Experiments

Credit: NASA SP 4210

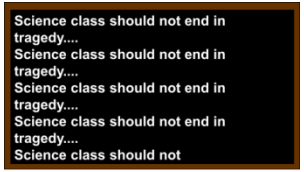


- → The first spaceflight missions to use this Code-of-Conduct were the Ranger missions in 1961
- → Since then, all planetary missions had to implement planetary protection measures at different degrees – ranging from simple documentation to terminal sterilization of entire flight systems
- → More detailed quantitative regulations, in particular for Mars, were adopted by COSPAR in 1964 (e.g., C. Sagan and S. Coleman, *Astronautics & Aeronautics*, 1965; C. Sagan, E. C. Levinthal, J. Lederberg, *Science*, 1968)

# Rational for planetary protection

Ensure that scientific investigations related to the origin and distribution of life are not compromised

- → *Protect our investment in space science & exploration*
- → *Unique opportunity to learn more about the origin of life in a way that is no longer possible on Earth*
- → *And than there is the more philosophical issue about the Drake equation*



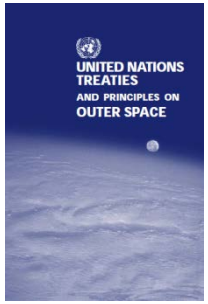

Bart Simpson, Dec. 17, 2000, "Skinner's Sense of Snow"

Protect the Earth from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission

→*Simple prudence - protect the Earth!*
→*In line with the precautionary principle of environmental protection*

# Framework for planetary protection

The legal basis and the goal for planetary protection was established in Article IX of the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty)




"...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 maintains and promulgates a planetary protection policy for the reference of spacefaring nations, both as an international standard on procedures to avoid organic constituent and biological contamination in space exploration, and to provide accepted guidelines and requirements in this area to guide compliance with the wording of the Outer Space Treaty

# Planetary protection categories

The different planetary protection categories (I-V) reflect the level of interest and concern that contamination can compromise future investigations; the categories and associated requirements depend on the target body and mission type combinations

**Category I:** All types of mission to a target body which is not of direct interest for understanding the process of chemical evolution or the origin of life

**Category II:** All types of missions (gravity assist, orbiter, lander) to a target body where there is significant interest relative to the process of chemical evolution and the origin of life, but where there is only a remote[1] chance that contamination carried by a spacecraft could compromise future investigations

**Category III:** Flyby (i.e. gravity assist) and orbiter missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations

**Category IV:** Lander (and potentially orbiter) missions to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant[2] chance of contamination which could compromise future investigations

**Category V:** Two subcategories exist - unrestricted Earth return for solar system bodies deemed by scientific opinion to have no indigenous life forms, and restricted Earth return for all others

[1]Implies the absence of environments where terrestrial organisms could survive and replicate, or a very low likelihood of transfer to environments where terrestrial organisms could survive and replicate

[2]Implies the presence of environments where terrestrial organisms could survive and replicate, and some likelihood of transfer to those places by a plausible mechanism

# Planetary protection categories

**Category I:** Flyby, Orbiter, Lander: Undifferentiated, metamorphosed asteroids; others TBD

**Category II:** Flyby, Orbiter, Lander: Venus; Moon (with organic inventory); Comets; Carbonaceous Chondrite Asteroids; Jupiter; Saturn; Uranus; Neptune; Ganymede†; Titan†; Triton†; Pluto/Charon†; Ceres; Kuiper-Belt Objects > 1/2 the size of Pluto†; Kuiper-Belt Objects < 1/2 the size of Pluto; others TBD

**Category III:** Flyby, Orbiters: Mars; Europa; Enceladus; others TBD

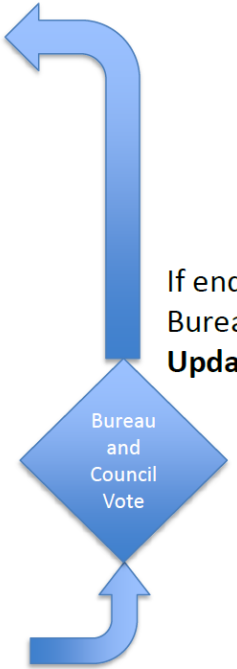
**Category IV:** Lander Missions: Mars; Europa; Enceladus; others TBD

**Category V:** Any Earth-return mission.
"Restricted Earth return": Mars; Europa; Enceladus; others TBD
"Unrestricted Earth return": Venus, Moon; others TBD

†Additional analysis is required.

# Maintaining the planetary protection policy

- COSPAR Planetary Protection Policy
  (COSPAR Bureau- and Council-endorsed version in this publication)
- New phenomena reported/new missions proposed/other external considerations
  (Peer reviewed scientific literature/request from private or public entity/recommendations from agency advisory groups)
- Possible study by a scientific organization and/or a COSPAR-sponsored workshop
  (May be solicited by space agencies and carried out by a National Scientific Institution or International Scientific Unions)
- Panel on Planetary Protection meeting
  (Panel business meeting at COSPAR Scientific Assemblies or dedicated COSPAR Panel Colloquium, involving representatives of the scientific community and other relevant stakeholders)
- Panel recommendation to Bureau & Council
  (At COSPAR Scientific Assemblies or at COSPAR Bureau meetings between Assemblies)

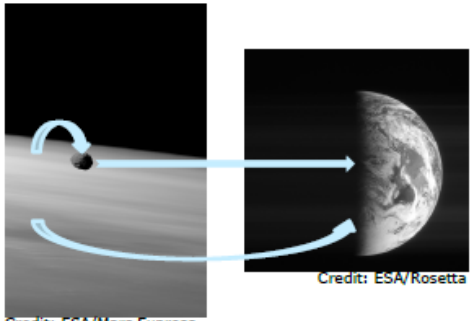


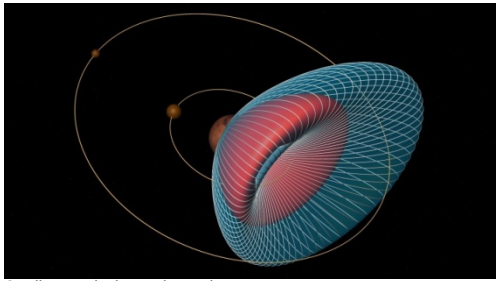

If endorsed by the Bureau and Council, **Update to Policy**

# Phobos (Deimos) sample return

In support of mission studies an assessment of planetary protection categorization for Phobos sample return missions has been initiated

- → Transfer of material from Mars to Phobos (Melosh *et al*., 2011)
- → Different models predict an abundance of martian material on Phobos in the ppm range with uncertainties that span several orders of magnitude (Chappaz *et al.,* 2012; Ramsley and Head III, 2013) and major transfers as young as 3 million years (Werner *et al*., 2014)
- → Level of biological inactivation of material transferred from Mars to Phobos due to hypervelocity impact on Phobos and exposure to the ionizing radiation and temperature environment on the surface and near sub-surface of Phobos is uncertain





Credit: J. Melosh, Purdue Univ.


Credit: Werner *et al.,* 2014, NASA MRO CTX

# Un-restricted Earth return

For solar system bodies deemed by scientific opinion to have no indigenous life forms

→ Planetary Protection requirements on the outbound phase only, corresponding to the category of that phase (typically Planetary Protection Category I or II)

→ Examples: Hayabusa I, Hayabusa II, Stardust, Genesis, Marco-Polo

# Restricted Earth return

All others

→ “Based on current knowledge of past and present habitability of Mars, NASA should continue to maintain a strong and conservative program of planetary protection for Mars sample return. That is, samples returned from Mars by spacecraft should be contained and treated as though potentially hazardous until proven otherwise. No uncontained martian materials, including spacecraft surfaces that have been exposed to the martian environment, should be returned to Earth unless sterilized.”, NRC-SSB 2009

→ Substantial impact on flight hardware, reliability and redundancy, mission operation & ground operation post return → consequences in schedule and cost

→ Examples: Mars sample return campaign studies

# Task for study

Evaluate the level of assurance that no unsterilized martian material naturally transferred to Phobos (or Deimos) is accessible to a Phobos (or Deimos) sample return mission

# Task for review

Review the study results and formulate recommendations for the planetary protection categorisation of one-way and return missions to Phobos and Deimos

# Maintaining the planetary protection policy

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- New phenomena reported/new missions proposed/other external considerations
  (Peer reviewed scientific literature/request from private or public entity/recommendations from agency advisory groups)

✓

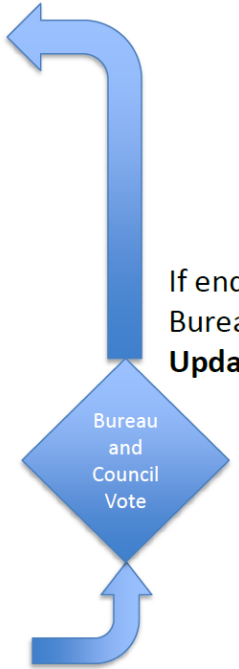
- Possible study by a scientific organization and/or a COSPAR-sponsored workshop
  (May be solicited by space agencies and carried out by a National Scientific Institution or International Scientific Unions)

Spring 2018

- Panel on Planetary Protection meeting
  (Panel business meeting at COSPAR Scientific Assemblies or dedicated COSPAR Panel Colloquium, involving representatives of the scientific community and other relevant stakeholders)

July 2018

- Panel recommendation to Bureau & Council
  (At COSPAR Scientific Assemblies or at COSPAR Bureau meetings between Assemblies)

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