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What Can NASA Do to Better Protect the Planets It Probes?

NASA's policies to protect solar system objects against earthly contaminants need significant updates, according to a new report. The report, released in early July, was compiled by a committee of the Space Studies Board (SSB) of the National Academies of Sciences, Engineering, and Medicine.

In the report, the committee emphasizes that many current policies concerning robotic and human exploration are governed by outdated protocols, some of which were issued during the Apollo era 50 years ago [*National Academies of Sciences, Engineering, and Medicine,* 2018]. Since then, however, we've discovered that the most tenacious microbes can survive extended time in the vacuum of space, that water is pervasive throughout much of the solar system, and that more places than we knew may be capable of supporting life.

The risks of perpetuating those outdated policies are great, the report explains. If scientists don't thoroughly sterilize spacefaring technology before launch, they could get false positives in the search for life beyond Earth. Such contamination could also permanently alter off-planet environments should those Earth microbes grow and flourish elsewhere. We've even started contemplating returning samples from Mars and other bodies back to Earth—are we protected from any microorganisms that may hitchhike back? The possibility of back contamination, which refers to extraterrestrial microbes reaching Earth, adds another layer of complexity to the problem.

Advances in scientific understanding of the solar system combined with new sample return initiatives and shrinking budgets have created new challenges for planetary protection, noted Joseph Alexander, chair of the committee that wrote the report. Hence, the report's purpose: to help NASA maintain its decades-long success in developing planetary protection policies.

"Soundly framed and executed planetary protection policies will play a critical role in ensuring that space exploration efforts will deliver unambiguous answers about the possibility of life elsewhere in the solar system," Alexander said.

"NASA welcomes the release of the Space Studies Board report," NASA's Office of Planetary Protection (OPP) told *Eos*, adding that the report's recommendations "are consistent with the collaborative decision-making process to be used for missions scheduled to Mars and Europa."

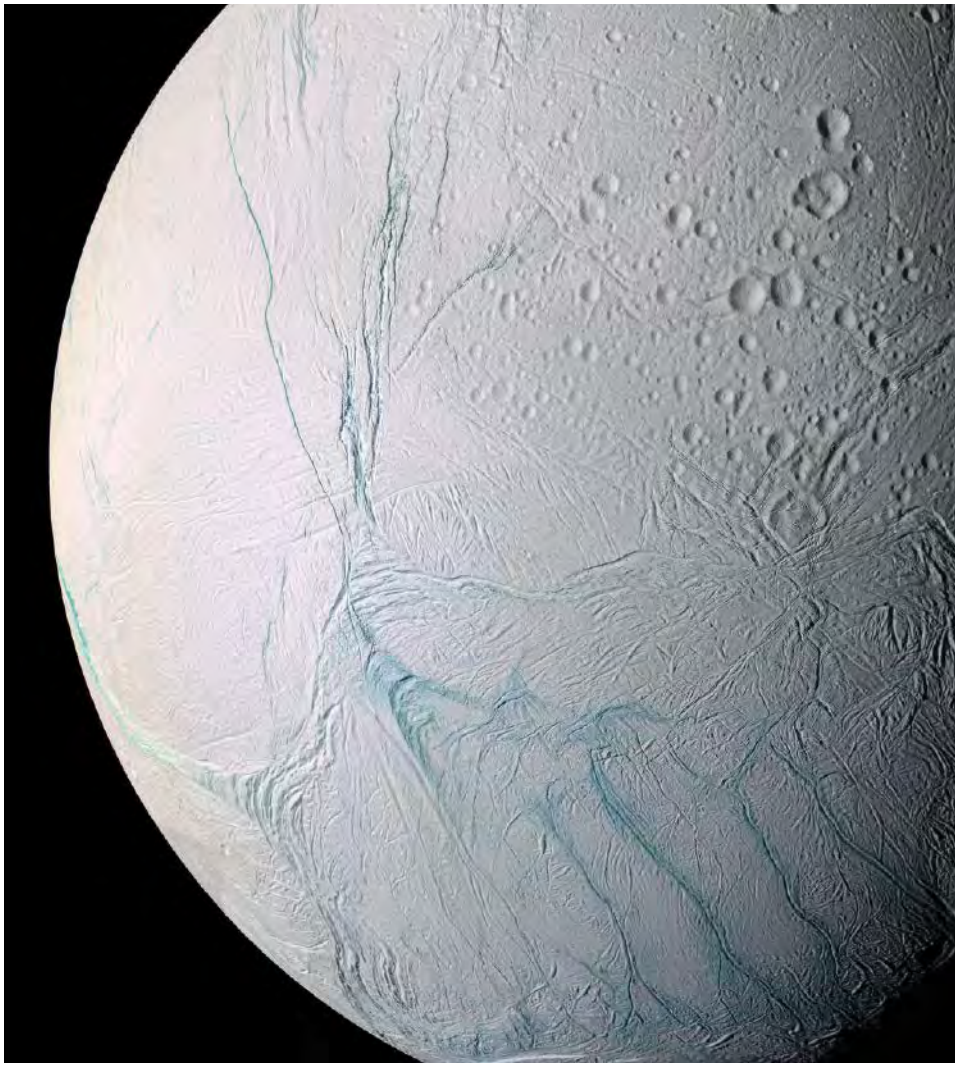
Here are four key recommendations from the report.

1. Keep with International Policy

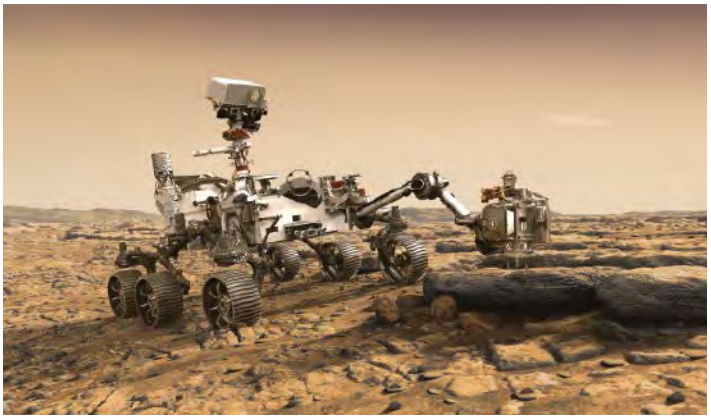
Planetary protection has been international policy since the 1967 ratification of the United Nations' Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, colloquially dubbed the Outer Space Treaty (http://bit.ly/UNOOSAtreaty). Among its provisions is the agreement that signatory nations, which include the United States, must ensure that they avoid harmful contamination of any celestial bodies.

The SSB committee advises that NASA needs to keep up to date with changes to international planetary protection policies made by the Committee on Space Research (COSPAR). COSPAR has maintained the de facto, international consensus planetary protection policy since its establishment in 1958. COSPAR's Panel on Planetary Protection issued its most recent policy update in December 2017 (http://bit.ly/COSPARppp).

In addition, the committee calls out NASA's current process for developing new policies and updating its old ones as ill defined, unregulated, and too slow to keep up with current consensus. "The current planetary



An enhanced color image of Saturn's moon Enceladus taken by NASA's Cassini spacecraft. The blue streaks mark areas where the surface ice has cracked and the subglacial ocean has upwelled. Credit: NASA/JPL/Space Science Institute



Artist's conception of the Mars 2020 rover examining a rocky outcropping. Credit: NASA/JPL-Caltech

protection policy development process is inadequate to respond to progressively more complex solar system exploration missions," the report says. Increasingly ambitious mission goals, like returning samples from Mars or exploring regions with the potential for life, have begun to outpace the development of policies to regulate how to safely meet them.

To avoid setting mission objectives that it later finds violate policy, NASA should consider "securing relevant outside expert advice" and "developing a long-range forecast of future solar system exploration missions having planetary protection implications," the report notes.

2. Update Apollo-Era Sample Return Protocols

The report highlights an instance in which the lack of clear policy and oversight led to conflict. In 2015, scientists used the Mars Reconnaissance Orbiter to discover a region near the Curiosity rover on Mars where water was thought to intermittently flow. Curiosity couldn't traverse the distance, but even if it could have, it would not have been allowed to investigate further because it had not been decontaminated to the proper extent before launch.

NASA's current plan to carry Curiosity's now obsolete protocols forward may hinder the Mars 2020 sample return mission, which led to a "3-year long…and often contentious discussion" between the Mars 2020 project team and NASA OPP, the report says. The discussion focused on whether the project's planetary protection plans were now sufficient, whether the team accounted for all possible contamination sources, and whether the team was accurately modeling the spread of contaminants.

The bottom line is, "The current U.S. government process to oversee samples returned from Mars and elsewhere dates back to the Apollo era and is out of date," according to the report. Furthermore, some of the Mars sterilization procedures were developed for Viking in the 1970s and are not compatible with Mars 2020's more delicate technology.

Early collaboration between project teams, mission developers, science teams, and microbiologists is key when creating protection policies for sample return missions, the committee says. The report also points out that NASA has not yet defined policies protecting Mars from microorganisms, foreign organic carbon, and human biological matter like waste during its proposed human exploration missions. Those protection plans must be in place before mission development proceeds, the committee states.

3. Consider the Added Risks to Ocean Worlds

Landers and orbiters around ocean worlds like Europa, Enceladus, and Titan present further contamination risks due to the known presence of water or other liquids on their surfaces. "It's not just the landers that have planetary protection requirements," NASA's current planetary protection officer (PPO), Lisa Pratt, told *Scientific American* (http://bit.ly/SciAmPratt), "it is the flybys and the orbiters because of the possibility that they could come down on the surface."

One issue highlighted in the report concerns the Europa Clipper mission, in which a spacecraft will target the Jovian moon. During development, a former PPO had imposed on the project team illogical or scientifically inaccurate parameters for use in a contamination algorithm without giving the science team an avenue for rebuttal.

The incident highlighted for the SSB committee that the most accurate science was not always used to assess contamination risks, a problem that could have affected Europa Clipper, the proposed Titan explorer Dragonfly, and a proposed spacecraft to fly through Enceladus's plumes.

To prevent these problems in the future, the report recommends early definition of protection requirements for a project, following standard procedures for conflict resolution, and reevaluating legacy protocols to ensure their accuracy for current missions. This course of action will keep mission costs low and streamline project development, it notes.

4. Account for and Include the Private Sector

Some U.S.-based private spaceflight companies have recently set their sights on exploration and tourism on the Moon and Mars, which compromises the United States' ability to comply with the Outer Space Treaty, the report finds.

As the report summarizes, the treaty requires signatories to "authorize and continually supervise non-governmental entities, including private sector enterprises, for any space activity that implicates the treaty, including its planetary protection provisions."

The report points out that no federal agency has jurisdiction to authorize or supervise in such a way, presenting a potentially dangerous regulatory gap. This regulatory gap became apparent when SpaceX launched its Falcon Heavy rocket in February, complete with an unsterilized Tesla Roadster on a Mars-crossing orbit. Beyond SpaceX, Pratt has also expressed concern about private development of CubeSats, which are often not hardy enough to withstand rigorous sterilization. Not closing this gap could quickly render all federal efforts at planetary protection moot, the report says.

To integrate the private spaceflight sector into the planetary protection policy, the committee recommends that the regulations apply equally to government and private sector space endeavors, particularly for future missions to Mars. It also recommends that private sector representatives be involved in developing these policies and that Congress authorize a federal agency, NASA or another body, to oversee private sector activities that could compromise planetary protection.

NASA OPP told *Eos* that it strongly agrees with "the call to work with multiple stakeholders to develop clear policies on the biological cleanliness of commercial and private spacecraft with destinations at Mars, Europa, and Enceladus."

The agency said that it will conduct a thorough review of the report's recommendation and give "a comprehensive response in due time."

References

National Academies of Sciences, Engineering, and Medicine (2018), *Review and Assessment of Planetary Protection Policy Development Processes*, 170 pp., Natl. Acad. Press, Washington, D. C., https://doi.org/10.17226/25172.

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