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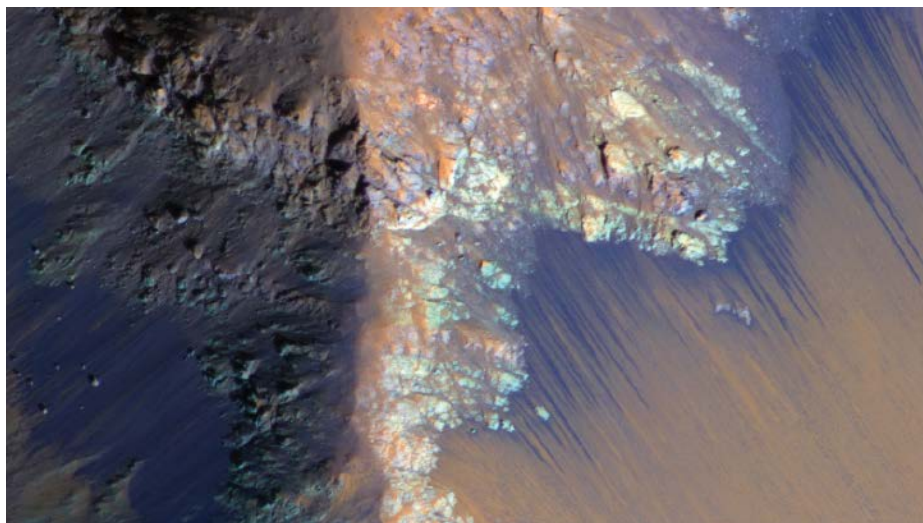
The Next 100



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ADVANCING EARTH
AND SPACE SCIENCE

Protecting Potential Life at the Cost of Exploration



Recurring slope lineae on Mars, like these dark streaks seen by the Mars Reconnaissance Orbiter, were thought to be caused by actively seeping water. More recent research suggests that liquids have a very minor role in their formation. Credit: NASA/JPL-Caltech/University of Arizona

“Our guidelines on how we protect the places we’re going from contamination and how we protect our own planet on the way back are in urgent need of updating,” Thomas Zurbuchen, the head of NASA’s Science Mission Directorate, told reporters at an October press conference. Those guidelines for planetary protection must be updated, streamlined, and uniformly implemented across the agency and the private sector, according to a new report (bit.ly/potential-life).

NASA convened the Planetary Protection Independent Review Board (PPIRB) earlier this year to address concerns about its planetary protection guidelines. Past reviews found that the protocols are based on Apollo-era science and technology, are unevenly applied to exploration missions, can be a significant burden to low-budget missions, and fail to address the private sector of the spaceflight industry.

The PPIRB’s 18 October report “really addresses both our changing knowledge of other worlds in our solar system and the changing landscape of space exploration itself,” said Lucianne Walkowicz, an astronomer at the Adler Planetarium in Chicago who was not involved with the report. “This report is a great first step in reassessing what we think we know, so we determine a better path forward.”



A commercially built capsule, the SpaceX Dragon, lands on Mars in this artist’s rendering. Credit: Kevin Gill, CC BY 2.0 (bit.ly/coby2-0)

Being Realistic About Risk

Since the 1960s, international space policy has considered the entirety of a world to have a singular potential to develop life or to have foreign life catch on. But now, “we have a much more nuanced, and for that matter, sophisticated, view,” said Alan Stern, who led the PPIRB and is a planetary scientist at the Southwest Research Institute in Boulder, Colo.

“While some places on Mars have high interest for understanding the potential for past life on Mars or even prebiotic development of life, not all places on Mars have that potential,” Stern said.

On the basis of discoveries like that, the PPIRB report recommends that after more

study, some regions of the Moon and Mars might be recategorized to a lower protection level. Doing so would significantly lower the cost burden on missions targeting the “unsuitable” areas, the board concluded.

“If space policy is not informed by scientific advancement, then it will put undue pressures on space exploration,” said Edgard Rivera-Valentín, who was not involved with the report. They are a planetary scientist at the Universities Space Research Association and the Lunar and Planetary Institute in Houston.

Walkowicz had mixed feelings. “On the one hand, having region-specific planetary protection ratings acknowledges that different environments exist on any given body and is more in keeping with what we know about these worlds. I’m a bit concerned, though, about the level of deep knowledge needed to do something like that.”

For example, she said, it may not make sense to categorize subsurface regions on Mars on the basis of surface features. “I think there’s still a lot of room for error, which worries me when I think about the potential cost to Mars, particularly as a site of astrobiological interest,” she said.

Tardigrade Stowaways

Private spaceflight initiatives should hold to the same planetary protection standards as NASA, but those policies should not stymie commercial progress, the board recommended.

“As NASA prepares for more frequent missions...through commercial partnerships, it is important that the U.S. government’s policies enable these missions,” Tommy Sanford, executive director of the Commercial Spaceflight Federation in Washington, D.C., told reporters.

The report also calls for transparency and accountability from commercial companies should something go wrong. The review board highlighted the Beresheet lander developed by SpaceIL that crashed on the Moon earlier this year. It was later discovered that an undisclosed cache of DNA samples and tardigrades was on board. Although including them was not illegal, the lack of transparency concerned many in the planetary protection community.

The report recommends enacting sanctions against bad actors and holding the people who provide a payload, rather than those who launch it, accountable.





NASA's upcoming Dragonfly mission (artist impression) will land on the surface of Saturn's moon Titan, which has a subsurface liquid water ocean. Credit: NASA

However, "I believe sanctions are only an effective method up to a certain point, specifically, a certain profit margin," said Monica Vidaurri, an astrobiologist and policy and ethics specialist. Vidaurri is consulting for NASA Goddard Space Flight Center in Greenbelt, Md., and was not involved with the report. The report is a "great start," she said, but the policy will need to be explicit in how sanctions would work "rather than just a broad intent of meeting breaches with sanctions."

"I believe the next steps are for the space community to begin to come to terms with and have the difficult discussion surrounding who the main actors are in space and whether the goals they have are inherently globally just," Vidaurri said.

Customizing Ocean Moons

The PPIRB recommended extensive study of the ways in which ocean worlds transport material from their icy surface to the subsurface ocean before spacecraft attempt to land. NASA has two upcoming missions to ocean worlds: Dragonfly to Titan and Europa Clipper to Europa.

"We just need to sit down and really talk about these worlds and what the transport mechanisms are and how viable terrestrial microorganisms might be in their oceans," said PPIRB member Amanda Hendrix of the Planetary Science Institute in Lakewood, Colo. It's possible that each ocean world will need a

separate treatment under the new planetary protection standards, the board said.

"A lot of the report mentions that the likelihood that organisms can survive in various interesting planetary environments, like Mars [and] the subsurface of Europa, is very small," Walkowicz said. "While I applaud the planetary science community's efforts to carry out studies to determine whether that statement is true, I am also concerned that we don't yet know that it is true. I think a lot about the cost of being wrong, what is or may be lost."

"To ensure proper care when we visit bodies beyond Earth, space policy needs to keep up."

"I think there are some exciting opportunities for people to think creatively, not only about how we clean our spacecraft but even about how we choose materials to construct them that might better enable missions to meet planetary protection requirements," she said.

Dealing with Human Contamination

"This is a really timely report because our nation is preparing to return humans to the Moon with the hopes of this time those first steps being a giant leap toward Mars," Rivera-Valentín said.

Human space exploration will be messy, the board concluded, and humans will inevitably contaminate any environment by living there for an extended time. "I strongly agree with the PPIRB that planetary protection planning for human missions is immature and that the current planetary protection rating for Mars precludes human missions," Walkowicz said.

Will astrobiology missions still be viable in places with human explorers nearby? The review board recommends finding out ahead of time whether the two mission types should be segregated.

"I am glad to see the attention...on determining how astrobiological investigations can be carried out with human involvement," Walkowicz said. "It's particularly smart to think about these missions as extensions of the exploration of sensitive analogue environments here on Earth like the Atacama or Antarctica, as I suspect there are lessons we can learn there."

Implement Early and Update Often

NASA should set the planetary protection standards for a mission early in the mission's planning and development phases to keep costs down, the review board recommended. "Not only is it cost-effective," Vidaurri said, "but [it] helps establish these practices as custom, which is absolutely crucial since the review calls on communicating new planetary protection approaches to the United Nations that other nations will then be encouraged to employ."

NASA's planetary protection policies have not substantially changed in 50 years. The report recommends that going forward, NASA examine and update its policies at least twice a decade and establish a forum for ongoing discussion.

"Planetary science and astrobiology are fast growing fields because they are exploration science, as in they are constantly being motivated by new observations and discoveries rather than by hypotheses," Rivera-Valentín said. "To ensure proper care when we visit bodies beyond Earth, space policy needs to keep up."

By **Kimberly M. S. Cartier** (@AstroKimCartier), Staff Writer

