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Preventing the Forward Contamination of Mars—*Summary*

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Background

Recent spacecraft and robotic probes to Mars have yielded data that are changing our understanding significantly about, among other things, the possibility of existing or past life on that planet. Coupled with advances in biology and life-detection techniques, these developments place increasing importance on the need to protect Mars from contamination by Earth-borne organisms. To help with this effort, NASA requested that the NRC examine existing planetary protection measures for Mars and recommend changes and further research to improve such measures. This report discusses policies, requirements, and techniques to protect Mars from organisms originating on Earth that could interfere with scientific investigations. It provides recommendations on cleanliness and biological burden levels of Mars-bound spacecraft, methods to reach those levels, and research to reduce uncertainties in preventing forward contamination of Mars.

Findings

Many of the existing policies and practices for preventing forward contamination are outdated in light of new scientific evidence about Mars and current research on the ability of microorganisms to survive in severe conditions. In addition, a host of R&D efforts are needed to update planetary protection requirements, and such updating will require additional budgetary, management, and infrastructure support. Finally, the transition to a modern planetary protection regime will require a clear plan and timeline.

Recommendations

Research and Development Specific knowledge of organisms present during assembly, test, and launch operations (ATLO) and that have the potential to survive a trip to, then possibly grow on, Mars should allow engineers to tailor spacecraft and instrumentation decontamination methods. NASA should ensure reliable assessment of the microbial diversity present in ATLO environments and spacecraft to be sent to Mars; sponsor research on those microorganisms most likely to grow in potential martian environments; determine the bioburden in spacecraft materials; sponsor studies of alternative bioburden reduction techniques; and sponsor research on non-living spacecraft contaminants and their potential to confound scientific investigations for life. NASA should also take steps to make the transition to a modern approach for assessing bioburden on spacecraft.

Interim Requirements The existing framework for planetary protection methods should be updated to reflect recent scientific findings about Mars and microorganisms. The most

critical issue concerns “special regions,” which are possible regions on Mars where certain microorganisms from Earth might be able to grow, or where life might already exist. Currently, there are insufficient data to distinguish regions that are “special” from those that are not. NASA should assign high priority to defining and obtaining measurements needed to identify special regions on Mars. Until then, NASA should treat all direct Mars contact missions as going to special regions.

Managing the Transition The transition from current practice to one reflecting current scientific understanding of Mars and microbiology will require R&D investments and assessments of new technologies. It also will depend on an infrastructure for managing that R&D and coordinating relevant engineering, spacecraft/instrument development, and science communities. NASA should establish a coordinated initiative—including the management capability and infrastructure—and provide sufficient funds to carry out the R&D on and implementation of improved planetary protection procedures. It also should establish an independent review on a three-year cycle to consider the latest scientific information about Mars and Earth microorganisms and to identify the highest priority measurements needed on Mars to inform future assessments. The review panel should provide input to any updates of planetary protection policies and requirements, as needed, in response to evolving scientific understanding of Mars and microbiology.

Reconsidering Planetary Protection Recent discoveries suggest that there may be environments on Mars where the potential exists for terrestrial organisms to grow. Inadvertent introduction of terrestrial organisms into these environments might pose a long-term threat to any indigenous biosphere that might exist. NASA should work with the international Committee on Space Research (COSPAR) and other appropriate organizations to convene an international workshop on whether planetary protection policies for protecting scientific investigations, especially those concerning the search for life on Mars, should be extended to include protecting the planet itself.

Transition Plan, Process, and Timeline The recommendations outlined above build on each other and should be considered as a roadmap to a modern planetary protection regime. As such, it is important to review and adjust Mars forward contamination requirements and procedures as expeditiously as possible. There will be an opportunity during FY2008 to begin to test and demonstrate the effectiveness of new bioburden reduction requirements and procedures emerging from research efforts. A new completely validated planetary protection protocol could reasonably be accomplished on a mission for launch early in 2016.

Four objectives are critical for this transition plan: 1) determine what microbes are present in Mars missions, and which actually pose a threat; 2) review and revise existing bioburden reduction standards; 3) explore alternative bioburden reduction techniques that are potentially more effective; and 4) test and validate the knowledge gained from meeting the prior objectives. Assuming that a detailed research plan embracing these objectives is developed and funded within the next few years, NASA could accomplish the first three within the next six years. Finally, because of the sequential nature of the objectives, independent, periodic review of research progress is highly desirable.

For Further Information

Copies of the complete report, *Preventing Forward Contamination of Mars*, can be obtained from the Space Studies Board, The National Academies, 500 Fifth St., NW, Washington, DC, 20001, 202-334-3477, < <http://books.nap.edu> >.

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