

PLANETARY PROTECTION OBJECTIVES FOR MARS MISSION CONCEPTS OF THE NEXT DECADE.

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Introduction:

How will planetary protection be implemented once humans arrive at Mars? The international consensus policy on planetary protection [1] has provided a framework under which, based on best available scientific data, Mars has been protected against “*harmful contamination*” by terrestrial biota, as required under the terms of the 1967 Outer Space Treaty [2].

For robotic missions, this has been achieved by managing the viable microbial burden flown to Mars on spacecraft hardware, to limit the possibility that a terrestrial organism will be transported to a martian environment where it can replicate. However, studies have determined [e.g., 3] that this paradigm is unsustainable in the context of the crewed exploration of Mars: Current technology does not allow complete isolation between a crewed habitat on Mars and the martian environment. But the policy does not suggest that control of microbial contamination should be discontinued at the start of crewed exploration. On the contrary, the policy states: “*The intent of this planetary protection policy is the same whether a mission to Mars is conducted robotically or with human explorers. Accordingly, planetary protection goals should not be relaxed to accommodate a human mission to Mars. Rather, they become even more directly relevant to such missions—even if specific implementation requirements must differ*” [1].

Path Forward:

So how will the “*specific implementation requirements*” needed to protect future exploration be determined? Data and findings from Mars missions in the 2020s will be critical in providing the foundational information for design and operation of crewed missions to the surface planned for the 2030s, including the planetary protection aspects.

An incremental evaluation and development of requirements specific to crewed exploration is under way within the international scientific community. Hogan *et al.* [4] proposed a concept for establishing zones where terrestrial contamination could be managed with different levels of rigor, according to perceived threat of harmful contamination. However, there are gaps in our knowledge of Mars that would allow us to define zone boundaries and scale. These

knowledge gaps were discussed at a 2015 NASA workshop [5,6].

For example, intrinsic to the safe delivery and return of astronauts from Mars (while at the same time avoiding the harmful contamination of the planet based on “zoning”) is an increased understanding of the interaction of terrestrial biology with the martian environment. This includes, for example, a better understanding of the fate and effect of viable terrestrial microorganisms released deliberately or accidentally into the martian environment, as well as the effect on astronauts of exposure to martian material.

The knowledge gaps identified in the 2015 workshop were refined and prioritized at a COSPAR workshop in 2016 [7] and a future workshop [8] is planned to identify instrument and measurement capabilities needed to address and close the high priority knowledge gaps.

Conclusion:

Measurements that are needed for development of planetary protection requirements for crewed missions are synergistic with the overall scientific goals of understanding Mars’ habitability, climate processes and geology. However, care needs to be taken by space agencies to ensure the instruments flown are capable of making measurements at the level of resolution needed for planetary protection purposes as well as for acquisition of new scientific understanding.

References: [1] Kminek, G. et al. (2017) *Space Research Today* 200:12-25. [2] United Nations, Outer Space Treaty, Article IX, U.N. Doc. A/RES/2222/(XXI) 25 Jan 1967; TIAS No. 6347, 1967. [3] National Research Councils (2002) *Safe on Mars*; National Academies Press, Washington DC. [4] Hogan, J.A. et al., (2006) *Life Support and Habitation and Planetary Protection Workshop: Final Report*. NASA/TM-2006-213485. [5] NASA (2015) downloaded from: https://planetaryprotection.nasa.gov/file_download/119/Race_PP.Humans.Workshop.2015.pdf. [6] Spry *et al.* (2017) *Putting Planetary Protection Parameters in Place Ahead of the Human Exploration of Mars*; 47th International Conference on Environmental Systems, Charleston, SC. [7] COSPAR (2016) downloaded from: <https://planetaryprotection.nasa.gov/humanworkshop2016>. [8] NASA (2018) accessed at: <https://planetaryprotection.nasa.gov/humanworkshop2018>.