

A Hierarchy of Potential Hazards: Improving Stakeholder Engagement Through Science-informed Discussions of Backward Planetary Protection Risks. D. Isbell¹, B. G. Clement², A.B. Regberg³, B. Shirey⁴, B. Carrier⁵, A. Harrington⁶. ¹Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, douglas.m.isbell@jpl.nasa.gov, ²Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, brian.g.clement@jpl.nasa.gov, ³Astromaterials Research and Exploration Science Division, NASA Johnson Space Center, aaron.b.regberg@nasa.gov, ⁴Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, timothy.b.shirey@jpl.nasa.gov, ⁵Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, brandi.l.carrier@jpl.nasa.gov, ⁶Astromaterials Research and Exploration Science Division, NASA Johnson Space Center, andrea.d.harrington@nasa.gov.

Introduction: The potential hazards posed by returning material from Mars are constrained by fundamental laws of physics, chemistry, and biochemistry. While defining the potential consequences of releasing unsterilized Mars material on Earth is not feasible until sophisticated analyses is conducted, such as those in development for the planned Mars Sample Return (MSR) campaign, the types of potential hazards can be categorized and ranked by likelihood based on fundamental science.

This would contrast directly with a more common approach (even among Mars-focused scientists) of discussing potential hazard types as unbounded by basic biology. Such framing can alarm the public and, more critically, can discredit expert assessments and carefully considered mitigation efforts. Improving our best practices for communicating the potential hazards in extraterrestrial materials (and the astronauts exposed to them) would facilitate discussions among and between the Mars science community and external stakeholders regarding key planetary protection challenges for safe human exploration of Mars.

Additionally, within the scope of the MSR campaign, knowledge gained through the investigation of returned Mars samples affords an unparalleled opportunity to understand and mitigate any potentially inherent risks encountered by astronauts working and living on Mars.

Planetary Protection Context: The potential for active biology on Mars—whether now or in the ancient past—means Mars material is both a major current focus of astrobiology and the most significant near-term potential extraterrestrial hazard to our biosphere. Gaps in consensus and related policies concerning the likelihood of potential hazard types—as well as common misconceptions about analogous, well-described hazards present in Earth’s biosphere —

have yet to be addressed by a combination of scientific investigations and publicly accessible, scientifically informed discussions.

Proposed Stakeholder Engagement Campaign: We propose that NASA foster a new, continuing, two-way dialogue with external stakeholders with a central focus on current scientific knowledge about the potential biological hazards involved in returning samples and human explorers from Mars, and how such hazards will be addressed, including initial sample analysis in a high-containment laboratory. This effort should include early input and on-going participation from subject matter experts who may not be traditionally involved in space science, such as evolutionary biologists, virologists, and invasive species experts.

Potential Elements: Activities within this dialogue could include dedicated events, panel discussions, on-line question-and-answer sessions, and academic reports/publications. These could be supported over time via an evolving public outreach campaign utilizing social media, handout materials, and new explanatory infographics. The proposed campaign should include international partnerships with the planetary protection groups within other space agencies, particularly those planning planetary sample return missions in the near future.

Desired Outcomes: The outcomes of such an on-going dialogue should be mutually beneficial for both the space agencies involved and their many diverse stakeholders. Likely benefits would include a significantly improved awareness among non-expert audiences about why hazardous biology in extraterrestrial material is considered unlikely, and how comprehensive mitigation measures are employed by missions returning material from Mars. Informed by current scientific knowledge rather than the science fiction that often frames this discussion, such an effort would also

serve to demonstrate that space scientists are committed to keeping the public informed. This, in turn, would encourage support for the science community in the search for potential biosignatures across the solar system while protecting Earth's biosphere from potential harmful contamination.

Our presentation at the workshop will include further details about potential expert participants and types of events, an outline of possible topic areas, and some of the challenges involved in crafting an effective and sustainable campaign about this complex but vitally important topic.

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