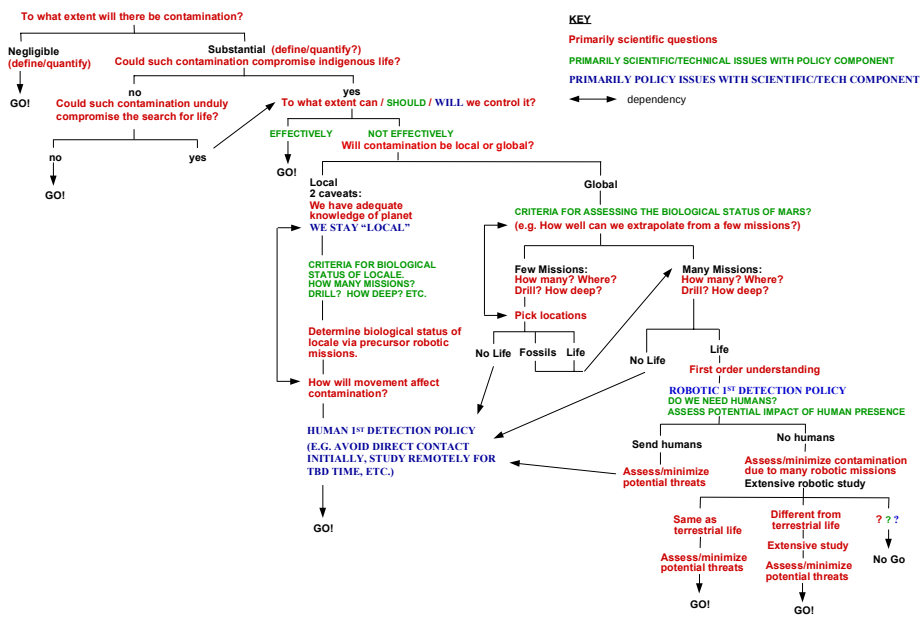
Human Mars Mission Contamination Issues

M. L. Lupisella

- A potential challenge for a human Mars mission is that while humans are by most measures the obvious best way to search for life on Mars, we may also be the most problematic in that we could unduly compromise the search for life by contaminating relevant environments and/or possibly adversely and irreversibly affecting indigenous life.
- Perhaps more problematic is the fundamental epistemic challenge of the "one data point" limitation which could decrease confidence in applying terrestrially based research to extraterrestrial life issues in general.
- An informal decision tree is presented as one way to begin thinking about contamination issues. There are many sub-questions and distinctions not shown such as biological vs. non-biological (but biologically relevant) contamination, viable vs. dead organisms, masking indigenous organisms vs. merely making the search more difficult, and independent origin vs. panspermia distinctions.
- While it may be unlikely that terrestrial microbes could survive on Mars, let alone reproduce and unduly compromise the search for life, the unpredictable potential for microbial life to survive, grow exponentially, evolve and modify (and sometimes destroy) environments, warrants focusing carefully on biologically relevant contamination as we prepare to send humans to the first planet that may have indigenous life-forms.

A Decision Tree for Addressing Human Mars Mission Contamination Issues



Summarizing thoughts:

- First questions first to avoid unnecessary resource consumption and unduly delaying a human mission. Obviously need more research/data to make informed decisions. Decision tree can help roadmap a research program.
- By addressing the issue now, we may find that the relevant precursor planning and execution should begin now.

  E.g. If contamination could go global, and if it is deemed necessary to assess the biological status of the entire planet (or just surface) with TBD confidence level, then many more life detection missions than otherwise thought may be required, likely effecting the overall program planning (especially schedule) for a human mission.
- Anticipates and addresses public concern.
- Contribute to astronaut safety - much of the research could inform procedural guidelines - e.g. how astronauts might be affected by indigenous organisms.
- Could help establish a planetary protection policy category to help guide program development for human exploration of the rest of the solar system and beyond.

Additional thoughts

- **"Traditional" national interests may not be the ultimate driver.** Alternatives might be:

  Search for a "second genesis" - not yet fully appreciated. E.g. practical implications such as medical, as well as more theoretical/general scientific rewards such as significance to understanding the nature of life. And the potential cosmological relevance: e.g. does the universe naturally produce life? "Is life a cosmic imperative?" Potential "world-view" relevance also. If the search for a second genesis is a primary driver, the contamination issue could be critical.

  Other motivations such as cultural significance (e.g. "Into the Unknown", inspiration for practical and emotional reasons, culture for its own sake), or perhaps international cooperation, may singularly, or together, be enough to justify a human mission. If we think these are important reasons, we should continue to cultivate them vigorously, both internally and with the public, and be a part of the motivation for a human mission, instead of of waiting for the political tide to raise our boats to Mars.
- **May need direct life-detection missions sooner than later** depending on criteria for assessing the biological status of locale, region, planet (surface or sub-surface?) - and depending on when we'd like to send humans. May be more feasible than we're imagining (technically, and cost) given a commitment and present work being done.

Additional thoughts con't

- **Co-evolutionary dependence is not required for organisms/species to adversely effect each other.** E.g. consumption of, and competition for, resources is likely fundamental to anything biological, giving rise to indirect effects such as competition for resources. Predation, toxicity, and general ecological disturbance (environmental modifications) are also possibilities that appear to transcend even a very broad notion of co-evolutionary dependence. So, the significance of, and unknowns of, a second genesis will likely call for much caution.
- **Worrying about this now may help boost confidence when the times comes for a decision**.
- **A near-human/"in-situ" tele-robotic mission could mitigate many contamination concerns, and others as well**. Here is a potential answer to what specific scientific pursuits require what kind of human/robot relationship. As we are doing with the broader program now, the near-human tele-operated mission could be done in a "seek, in-situ, sample" approach at the next level of exploration, that is, more detailed exploration with humans present on the planet, perhaps localized initially to a human base. If orbital data is insufficient, we can "seek" via tele-operated vehicles on the ground and in air (e.g. balloons/aerobots). In-situ searches for life and other science objectives can be pursued via tele-operating sophisticated robots at a specific locations from a home base. Samples can be brought back to the home base/lab on the surface or low Mars orbit, moon, etc., or perhaps an astronaut can go directly to a location to sample after sufficient tele-remote analysis. This keeps the human brain in the loop, allows for "real-time" responses and flexibility, and mitigates risk. Humans driving robots could also have surprising PR value - a different kind of "BattleBots" on Mars? Robots (and humans) challenged by the Martian environment instead...