FORWARD PLANNING FOR THE SCIENCE OF MARS SAMPLE RETURN--OPEN QUESTIONS AND NEXT STEPS. D. W. Beaty[1], B. L. Carrier[1], M. A. Meyer[2], and E. Sefton-Nash[3] (including on behalf of the MSR Science Planning Group (MSPG)), [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [3]NASA Headquarters, Washington, DC, [3]European Space Agency, ESTEC, The Netherlands

The purpose of this conference presentation is to seek community discussion of the issues presented below, and input into additional issues, if any, that are missing. All of this is input into planning for Mars Sample Return Science (MSR) over the next 1-2 years.

Introduction

Beginning with the April 2018 Statement of Intent regarding MSR, NASA and ESA initiated planning for a potential partnership to return the M-2020 samples from Mars to Earth. A fundamental premise of the partnership is that scientists funded by NASA, or from ESA Member (and Associate) States or other partnership nations would equitably share in the planning for MSR science as well as have equal access to the samples for collective scientific benefits and discoveries. As one component of that planning, the MSR Science Planning Group (MSPG) was chartered in late 2018 to begin addressing key outstanding science issues via a series of international workshops and to develop the framework for a science management plan. That plan was delivered in October 2019. It was not deemed possible to proceed to a full Returned Sample Science Management Plan because essential feedback was required from multiple MSR stakeholders and MSR is still in its study phase.. For this reason, planning has been divided into two phases: 1) Preparation of the framework of a Mars Returned Sample Science Management plan (the work of MSPG) [1], followed by 2) The construction of the complete Returned Sample Science Management Plan.

During the past year, NASA & ESA have initiated a major set of planning processes related to preparing to conduct the potential science of Mars Sample Return. A key vehicle for this planning was an important committee known as the MSR Science Planning Group (MSPG), which was implemented on an international basis.

Some of the major open science-related issues that have been defined so far include:

1) Development of a complete science management plan
2) Five open issues were identified at the January, 2019 workshop "MSR Science in Containment" for which follow-up action was recommended at a high level of priority [2]:
   a) The impacts of heat and radiation sterilization on geological samples needs urgent and detailed investigation. Establishing permissible sample sterilization parameters is required.

   <u>Discussion:</u> *Critical aspects of MSR science planning are dependent on establishing the experimental basis that the effects of sterilization on different aspects of sample science are acceptable (to science), AND that the physical conditions of sterilization are acceptable to policy-makers. A systematic matrix of such experiments is likely to take some time.*

   b) Is the benefit of x-ray imaging through sealed tube walls larger or smaller than the consequences?
   c) The effects of analytical techniques and associated sample preparation procedures, in general, upon sample properties is one that needs urgent investigation.
   d) How much overlap would there be between the Sample Safety Assessment Protocol and the general category of sterilization-sensitive scientific investigations?
   e) The possible degradation with time of the scientific attributes of martian geological samples in response to exposure to terrestrial environments needs urgent and detailed investigation.

   <u>Discussion:</u> *This will require a systematic set of experiments to constrain the extent of potential modification by terrestrial conditions of scientific signals in returned Mars samples. SRF activities cannot be planned so as to optimize the science without this information.*
3) Several areas requiring further work were also identified at the May, 2019 "Contamination Control"workshop , including [3]:
   a) Identifying how different procedures and analysis techniques contaminate samples.
   b) Optimizing procedures to minimize contamination throughout tube opening, basic characterization, and preliminary examination process by working with sample analogs.
   c) Determining the optimal materials for sample contact tools and performing tests to determine how contamination is transferred by these materials.
   d) Determining the number of an optimal materials for witness plates and procedural blanks to develop an effective contamination knowledge protocol.

Proposed Pathway Forward:

A Working Group, MSR Science Planning Group-2 (MSPG-2) would be established by the MSR agency partners which then works with the following assumptions:

1. The framework established by MSPG ("A Framework for Mars Returned Sample Science Management),"), subject to feedback provided by the MSR agency partners, will serve as the foundation for the Returned Sample Science Management Plan. The Framework document considers and incorporates all prior work, specifically including that completed by iMARS-2.
2. The main scientific objectives of MSR are those described by iMOST (2019) [4]—that report considers and incorporates all prior work.
3. The sample-related facility scenario is envisioned to include:
   a. A "BSL-4" rated Sample Receiving Facility (SRF) in the U.S. will be responsible for the in-

itial receipt of all returned flight hardware, including the samples. Within this facility the spacecraft would be opened, and the samples extracted. This primary SRF would provide sample containment until such time as the samples are deemed safe for release to the scientific community or are transferred (under containment) to another, equivalently rated, facility. Scenarios involving a second contained facility in Europe may be under consideration by the MSR agency partners, but it is not necessary to specify an assumption in this area for the purpose of this ToR.

b. Additional curation facility(s) may exist in the U.S. or in Europe. If an additional facility does not possess an equivalent biosafety rating to the SRF, then transfer of samples out of the SRF would only occur after appropriate criteria are met (e.g. sterilization). It is not necessary to specify an assumption regarding scenarios involving the configuration of additionals curation facilities for the purpose of this ToR.

c. Globally-located PIs have indicated desire access to samples at the SRF and eventually, if safe, access to samples distributed outside the SRF, for analysis at their own laboratories.

4. The decision on where to locate the U.S. SRF and a potential European biocontained or uncontained facility would need to be made in the context of the local and national laws and optimizing for capabilities; thus, this is not known (or knowable) at this time.
5. Personnel who work on MSPG-2 will be deemed not to have incurred a conflict of interest that disqualifies them from work on later aspects of MSR.

A Vision for What Needs to Be Done Within the Next Year

1. Using the October 2019 document "A Framework for Mars Returned Sample Science Management," along with feedback from NASA and ESA, and the draft or final MSR MOU, MSPG-2 will prepare the "Mars Returned Sample Science Management Plan." The group would be expected either to adopt recommendations, or to propose suitable alternatives, regarding open science management planning issues. The scope of this task will include, but not necessarily be limited to, the following:
   A. Within the "Framework" document, amplify the planning descriptions of all of the bodies & processes described in Section 4. This may include, but not be limited to, the following:
      i. preparation of draft ToRs,
      ii. conflict of interest avoidance planning,
      iii. planning for how the personnel will be chosen, reporting relationships, required deliverables, etc. etc.
      iv. constraining the timing of formation and expected duration
   B. Identify approaches for the MSR partners to operate either jointly or in close co-ordination for the publication of announcements of opportunity, proposal reviews and selection, and other activities for which timing should be synchronized.
   C. Define the interfaces, organizational relationships, and communication pathways between science, curation, M2020, facilities planners, and planetary protection
2. Address some or all of the technical issues (for example, the five topics listed in the introduction to this abstract) by means of convening representatives from the scientific community, conducting workshops, establishing topical committees, directed work, and/or the MSPG-2's own internal efforts. Emphasis is placed on the responsibility of this group to represent the view of the international science community and other stakeholders of Mars Sample Return science output.
3. Formulate strategies to maintain engagement with the science research community during this early planning period.

References: [1] MSPG (2019a). The Relationship of MSR Science and Containment. Unpublished workshop report, posted 04/01/19 at https://mepag.jpl.nasa.gov/reports/Science%20in%20Containment%20Report.pdf. [2] MSPG ((2019b) Science-Driven Contamination Control Issues Associated with the Receiving and Initial Processing of the MSR Samples. Unpublished workshop report, posted 09/20/19 at https://mepag.jpl.nasa.gov/reports/MSPG%20Contamination%20Control%20Report%20Final.pdf. [3] MSPG (2019c). A Framework for Mars ReturnedSample Science Management. Unpublished white paper, posted12/11/19 at https://mepag.jpl.nasa.gov/reports/MSPG_ScienceManagementReport_Final.pdf. [4] iMOST (2019). The Potential Science and Engineering Value of Samples Delivered to Earth by Mars Sample Return. *Meteoritics & Planetary Science (54)*. https://doi.org/10.1111/maps.13242