Mars Sample Return: Preparing for Sample-Based Data Management

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Introduction: The first samples of martian rocks have been collected by the Perseverance Rover. The science planning for Mars Sample Return (MSR) has now expanded beyond the collection of samples to planning for their return and analysis of samples on Earth, and consideration of how to track and incorporate sample data from the entire process, standardize it, and manage it for a range of users across the science community. In the MSR Science Planning Group Phase 2 (MSPG2) report related to the MSR Science Management Plan [1], the need for data standards and data archiving plans was acknowledged.

Mars Sample Return Data: A fundamental assumption of the MSR campaign has been that the samples are most valuable when considered as a collection [2]. While samples can only be collected and ultimately measured individually, much of the data associated with them will contribute to the analysis and interpretation of the full sample set, and how it applies to interpreting Mars.

Scientific data produced by the Perseverance rover are a critically planned part of the MSR science program. The Perseverance science team's strategy is to assemble the field data related to each sample in the form of a sample dossier. The plan is for the sample dossiers to begin with Mars 2020 metadata beginning from well before each sample is collected until the sample is placed in a depot or transferred to the Sample Retrieval Lander. The dossier would then be updated with information from later missions and modeling efforts documenting the environmental histories of the sealed samples from collection through delivery to the Sample Receiving Facility (SRF).

Once inside the SRF, the initial characterization process would produce more data in the form of the measurements collected during Pre-Basic Characterization (Pre-BC), Basic Characterization (BC), and Preliminary Examination (PE) that collectively would go into a sample catalog that would constitute the informational basis for the competition for scientific access to the samples.

MSPG2 Science Management Plan (SMP): One of the major findings in the SMP section of the final MSPG2 report was that a formal plan for data management should be produced as part of the work of a future science planning group, the MSR Campaign Science Group (MCSG).

The SMP presented an overview about the proposed Data Management Plan (DMP) for MSR Campaign Science Data, which includes the goals to (i) improve the quality and quantity of the scientific return of the sample collection; (ii) generate a long-term, documented archive for future analyses of the samples and reinterpretations and comparisons with new observations, and; (iii) demonstrate the transparency of the full program.

Although the specific drafting of the DMP was left for the future, some high-level considerations were described and included information about how data is shared with different users. For example, it was proposed that online access to MSR science data be the primary method for data distribution, using existing archives such as the NASA Planetary Data System (PDS) and the ESA Planetary Science Archive (PSA). Ideally, the latest data archive standard PDS-4 or any other dedicated, online archive should be employed. A key point is the need to establish data standards for different kinds of sample-based analytic data, and MSR will greatly benefit from precursor work in this area on other sample return missions.

It is assumed that all standard scientific data-sets would become publicly available at the NASA PDS and ESA PSA archives (if they are chosen as the sample database) after a proprietary period of (TBD) years where scientific datasets could only be used by the PI-led teams for publication after agreement provided by the owner of the scientific data-set.

Future Work: Additional consultation with data management scientists would be necessary for the planning outlined above. As part of the planning process going forward, having additional input into the best practices for data standards and data management from the scientific community who have worked these issues for sample return missions in the past is being actively sought, including as part of this workshop.

References:

[1] MPSG2 (2021) Rationale and Proposed Design for a Mars Sample Return (MSR) Science Program (in review) *Astrobiology*.

[2] MSPG (2019) A Framework for Mars Returned Sample Science Management. Unpublished white paper, posted 12/11/19 at https://mepag.jpl.nasa.gov/reports.cfm?expand=mspg.