OUTCOMES OF THE SCIENCE COMMUNITY WORKSHOP ON THE MARS 2020 MISSION FIRST SAMPLE DEPOT FOR THE MARS SAMPLE RETURN CAMPAIGN. A. D. Czaja[1], M.-P. Zorzano[2], G. Kminek[3], M. A. Meyer[4], D. W. Beaty[5], E. Sefton-Nash[3], B. L. Carrier[5], F. Thiessen[3], T. Haltigin[3,6], A. Bouvier[7], N. Dauphas[8], K. L. French[9], L. J. Hallis[10], R. L. Harris[11], E. Hauber[12], L. E. Rodriguez[3,13], S. P. Schwenzer[14], A. Steele[15], K. T. Tait[16], M. T. Thorpe[17,18], T. Usui[19], J. Vanhomwegen[20], M. A. Velbel[21], S. Edwin[22], K. A. Farley[23], D. P. Glavin[17], A. D. Harrington[24], L. E. Hays[4], A. Hutzler[3], M. Wadhwa[5,25], [1]University of Cincinnati (andrew.czaja@uc.edu), [2]Center of Astrobiology, CSIC-INTA(Spain), [3]European Space Agency, [4]NASA Headquarters, [5]Jet Propulsion Laboratory, California Institute of Technology, [6]Canadian Space Agency, [7]University of Bayreuth, [8]University of Chicago, [9]U.S. Geological Survey, [10]University of Glasgow, [11]Harvard University, [12]German Aerospace center (DLR), [13]Lunar & Planetary Institute, [14]The Open University, [15]Carnegie Institution of Washington, [16]Royal Ontario Museum, [17]NASA Goddard Space Center, [18]University of Maryland, [19]Japan Aerospace Exploration Agency, [20]Institut Pasteur, [21]Michigan State University, [22]Centers for Disease Control and Prevention, [23]California Institute of Technology, [24]NASA Johnson Space Center, [25]Arizona State University

Introduction: As the Perseverance rover collects samples in Jezero crater, NASA and ESA are advancing their planning for the safe and secure return of samples to Earth to conduct future scientific investigations. The strategy to maximize the probability of Mars Sample Return (MSR) success is to divide the samples into two caches, with "success" defined as the delivery of one of those caches of samples to Earth.

This strategy can be implemented by Perseverance placing a *First Depot* (a depot is a cache placed on the ground) in Jezero Crater, including one member of each of the paired samples Perseverance has collected so far. The second of each of the paired samples would be retained on board as the *Rover Cache*, and this group of samples would be augmented by the collection of additional samples. However, this strategy requires each cache to be independently scientifically return-worthy (SRW), meaning each has enough scientific value to justify the time, money, and effort for the MSR Campaign to retrieve those samples.

Mars 2020 Project Science and the MSR Campaign Science Group (MCSG) concur that Perseverance has assembled a sample collection that is SRW. A workshop was thus organized in September 2022 with the goal of soliciting input from the community on the definition of SRW and on whether they agree that the proposed set of samples for the First Depot meets this definition.

Community Workshop Details: The Mars 2020/MSR Community Sample Depot Workshop was organized by the MCSG and held on September 28 and 30, 2022. It was run on Webex and the total number of active attendees reached a maximum of 189. To facilitate participation and inclusion, a package of information was provided to the scientific community prior to the workshop and feedback was accepted throughout the duration of the workshop via several synchronous and asynchronous methods. At the end of the workshop, findings were summarized and presented to the community for confirmation, all of which were accepted. These findings as well as a description of the collection of samples and witness tubes that this group recommended including in the First Depot were incorporated into a report that was put forward to NASA and ESA decision-makers.

Scientific Return-Worthiness: The concept of SRW in relation to MSR was first formally defined by the Caching Strategy Steering Committee (CSSC) [1] and was edited slightly by the MCSG.

SRW definition. An SRW sample set should: 1) include distinct sample suites or individual samples selected to represent the diversity of an exploration area to address the science objectives of MSR described by iMOST [2], in general, and the astrobiological potential, geologic history, and evolution of Mars as reflected in the Jezero Crater region, in particular, 2) be accompanied by in situ data and information sufficient to understand the geological and environmental context of the samples, including sampling conditions, as documented by Mars 2020, and 3) include at least one (preferably two) witness samples.

Finding 1. After discussion of the assumptions and definition of SRW at the community workshop, there was consensus that these were appropriate criteria with which to determine the scientific return-worthiness of Mars 2020 sample collections.

SRW Evaluation of Proposed First Depot: The MCSG prepared a Sample Science Traceability Matrix (SSTM) by assessing the merits of the existing sample collection against the previously defined MSR science objectives and investigations as described by the iMOST group [2]. The SSTM and iMOST objectives were presented and these findings were reached:

Finding 2. The strategy of using a SSTM to assess the SRW of the depot by mapping the Mars 2020 samples to the MSR science objectives is valid.

Finding 3. The samples that have been collected so far can either fully or partially address each of the MSR science objectives.

Decision Guidelines for Paired Rock Samples: The MCSG developed a set of guidelines to decide which sample of each pair should go into each cache. Once Perseverance collects its next sample after leaving the First Depot, the Rover Cache becomes the more scientifically valuable sample collection and therefore higher priority to return. The series of proposed decision guidelines would result in the higher priority sample of each pair being kept in the Rover Cache, and the lower priority sample placed in the First Depot.

Finding 4. The shorter sample of each pair should be included in the First Depot, and the longer sample of each pair should be retained onboard Perseverance as the Rover Cache. [Note: one exception to this advice was made for samples collected after the workshop based on concerns about excessive exposure.]

Decision Guidelines for Atmospheric and Regolith Samples: Although an atmospheric sample and a regolith sample (a sample acquired at an aeolian bedform with the "regolith" bit) are not explicitly required in the definition of SRW, several iMOST objectives include proposed investigations that can be addressed partly or wholly by a sample of atmosphere and/or regolith [2] so planning has typically included one of each type in each cache.

Finding 5. An atmospheric sample should be included in the First Depot.

Finding 6. A regolith sample should be included in the First Depot.

Decision Guidelines for Witness Samples: Perseverance has five identical witness tube assemblies (WTAs) to provide contamination knowledge (CK) [3]. The first WTA, referred to as the bit carousel WTA (WB1), was activated prior to Assembly, Test, and Launch Operations and was sealed early in surface operations. The other four WTAs (WB2, 3, 4, and 5) can be used to provide CK for surface operations. WB2 and WB3 were utilized prior to the First Depot formation.

MCSG proposed placing either WB2 or WB3 into the First Depot, while all other WTAs would remain in the Rover Cache. This WTA allocation meets the minimum SRW definition. The community was in consensus with this proposed scenario with the preference to assign WB2 to the Rover Cache because WB2 was opened and sealed earlier in the mission and may have recorded more CK compared to WB3.

Finding 7. Mars 2020 should place WB3 in the First Depot and retain all other WTAs in the Rover Cache.

Review of the Sample Documentation: SRW requires that the returned samples should be accompanied by in situ data sufficient to understand the geological and environmental context of the samples. Thus, a review of the sample documentation led to the following finding:

Finding 8. The samples are sufficiently documented by accompanying in situ data and information to understand their geological and environmental context, including sampling conditions, as documented by Mars 2020 in the Initial Reports (IR) [4] and with the STOP (Standardized Observation Protocol) list observations that are archived in the Planetary Data System.

Workshop Summary: The community agreed with the following broad findings proposed by the MCSG:

Finding 9. The proposed First Depot sample collection is scientifically return-worthy.

Finding 10. There is overall community support for forming the First Depot as described at the workshop.

The primary outcome of the workshop can be summarized with a consensus statement: the proposed set of ten sample tubes that includes seven rock samples, one regolith sample, one atmospheric sample [5], and one WTA constitutes a collection that is SRW; and that: 1) represents the diversity of the explored region around the landing site, 2) covers partially or fully in a balanced way all of the iMOST scientific objectives that are applicable to Jezero Crater and 3) the analyses of samples in this First Depot on Earth would be of fundamental importance, providing a substantial improvement in our understanding of Mars. The community also recognizes that the diversity of the Rover Cache will be improved with the samples that are planned for collection in the future, both inside and outside Jezero crater, and that the Rover Cache is the primary target for MSR. We can anticipate that the iMOST objectives applicable to the Jezero Crater region will be fully covered with that extended collection.

Disclaimer: The decision to implement Mars Sample Return will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This document is being made available for informational purposes only.

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