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Introduction: The joint NASA/ESA Mars Sample Return (MSR) Campaign has a goal of returning a carefully selected cache of samples collected from Jezero crater, Mars. These samples are currently being collected by the Mars 2020 mission Perseverance rover (the first flight element of MSR; https://science.nasa.gov/mission/mars-2020-perseverance/mars-rock-samples/). Under the currently planned architecture, MSR has the potential to return up to 30 samples, including igneous rocks, sedimentary rocks, regolith, and atmosphere. MSR would fulfill one of the highest priority solar system exploration goals from the planetary science and astrobiology communities [1].

Once the samples have been returned to Earth, the MSR Sample Receiving Project (SRP) would support detailed scientific investigations, both within and outside of containment, to significantly advance our understanding of Mars, our solar system, and prepare for human exploration of the Red Planet.

Building upon previous efforts that enumerated the science goals and objectives of MSR [2-4], the MSR Campaign Science Group (MCSG) was tasked with defining the scientific objectives of the SRP. Here, we detail four overarching objectives, each with several subobjectives that would transform our understanding of the geological and astrobiological history of Mars and our solar system.

Objectives: The following objectives and subobjectives for the MSR SRP have been developed by the MCSG. Although we believe that these objectives can all be addressed to some extent with a subset of the samples M2020 has collected to date (e.g., the Three Forks Depot), the degree to which they can be addressed and the overall scientific return of MSR would be greatly enhanced as the diversity and number of samples to be returned increases.

1) *Reconstruct the formation and alteration history of the returned samples to transform our understanding of the geological processes and environments of Mars.*
   a) For the igneous samples, interpret the source region(s) (geochemical reservoirs), magmatic processes, chronological records, and their relationships to previously analyzed martian igneous rocks.
   b) For the ancient sedimentary samples, infer provenance, transport and depositional processes and environment, diagenetic processes, atmospheric volatile exchange, and evolution as a function of time.
   c) For all rock samples, quantitatively interpret post-lithification history, such as aqueous alteration, weathering, hydrothermal processes, or impact processes.
   d) For unconsolidated regolith samples, infer provenance, transport and depositional processes and environment, and interpret martian chemical and mechanical alteration processes, and as possible, the dynamic interaction between the martian atmosphere, dust, and regolith.
   e) For the atmospheric samples and the volatiles found within rock samples of known ages, advance our understanding of the history of the martian atmosphere.
2) *Determine the astrobiological significance of the martian geological record represented by the samples.*
   a) Interpret the habitability potential of the environments recorded by the rock and

atmospheric samples, as well as the extent to which potential biosignatures could have been preserved.

   b) Characterize and interpret any potential biosignatures within the samples, identifying feasible prebiotic/biotic/abiotic mechanisms for their formation, processing, and preservation.
   c) Assess the possible evidence of martian life in the samples, particularly in those determined to have the highest habitability potential.

3) *Provide new insights into planetary-scale formation and evolution of the inner Solar System.*
   a) Use the samples and the geological environments that they were collected from to further our understanding of planetary-scale processes (e.g., accretion, differentiation, volcanism, sedimentation, atmospheric formation/evolution/loss, and impact cratering).
   b) Constrain as much as possible the timing and nature of large-scale solar system events related to impacts and planetary dynamics.
   c) Quantitatively constrain the calibration of the martian cratering chronology method.
   d) Determine the ways in which volatiles have interacted with the martian crust, and, as possible, constrain the inventory of martian volatiles as a function of geologic time.
   e) Constrain the process and timing of the loss of the martian planetary magnetic field.
   f) Constrain the ways in which the atmosphere has changed over the martian geologic record and assess the martian (paleo-)climate.
4) *Identify and characterize potential risks and opportunities for future human missions.*
   a) Advance the definition and prioritization of science questions that could be addressed by investigations performed by future Mars astronauts.
   b) Assess the potential of martian materials (e.g., dust) to be a hazard to future human explorers.
   c) Evaluate the potential for martian natural resources that may be of interest to future human explorers.

These objectives will be used to define the measurement requirements for the samples in the receiving facility and create a sample science traceability matrix to evaluate the science value of the sample cache and eventually guide the prioritization of the samples that could be returned to Earth [5].

The investigations needed to achieve the SRP objectives would combine a broad array of advanced laboratory instruments and sample preparation methods impossible to achieve through *in situ* robotic exploration missions. Such analyses would provide a greater understanding of the chemical composition and diversity of the returned samples and examine small-scale features from known geologic contexts at higher sensitivity, lower detection limits, and finer spatial resolution than ever before. A portion of these samples would be archived and available for future generations of scientists to continually refine our understanding of Mars with even more capable instruments not yet invented.

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