THE IMPORTANCE OF RETURNED MARTIAN SAMPLES FOR CONSTRAINING POTENTIAL HAZARDS TO FUTURE HUMAN EXPLORATON.

iMOST Team (A. D. Harrington[1], B. L. Carrier, D. C. Fernandez-Remolar, J. Fogarty, J. T. McCoy, M. A. Rucker, J. A. Spry, F. Altieri, Y. Amelin, E. Ammannito, M. Anand, D. W. Beaty, L. G. Benning, J. L. Bishop, L. E. Borg, D. Boucher, J. R. Brucato, H. Busemann, K. A. Campbell, A. D. Czaja, V. Debaille, D. J. Des Marais, M. Dixon, B. L. Ehlmann, J. D. Farmer, D. P. Glavin, Y. S. Goreva, M. M. Grady, L. J. Hallis, E. M. Hausrath, C. D. K. Herd, B. Horgan, M. Humayun, T. Kleine, J. Kleinhenz, N. Mangold, R. Mackelprang, L. E. Mayhew, F. M. McCubbin, S. M. McLennan, H. Y. McSween, D. E. Moser, F. Moynier, J. F. Mustard, P. B. Niles, G. G. Ori, F. Raulin, P. Rettberg, N. Schmitz, E. Sefton-Nash, M. A. Sephton, R. Shaheen, D. L. Shuster, S. S. Siljestrom, C. L. Smith, A. Steele, T. D. Swindle, I. L. ten Kate, N. J. Tosca, T. Usui, M. J. Van Kranendonk, M. Wadhwa, B. P. Weiss, S. C. Werner, F. Westall, R. M. Wheeler, J. Zipfel, M. P. Zorzano, [1]Astromaterials Research and Exploration Science (ARES) Division, NASA Johnson Space Center, Houston, TX 77058, USA (Andrea.D.Harrington@NASA.gov).

Introduction: Mars has been the target for future human exploration for decades. However, even after the successes of the orbital, lander, and rover missions, there are still an array of unknowns that pose potential physical, chemical, and biological hazards to human health from the martian environment. Mars sample return represents a vital next step in understanding these hazards and mitigating the risks to both the explorers and the inhabitants of Earth.

Mars 2020 is a first step in a potential multipart Mars Sample Return Campaign. The regolith and drill core samples collected and cached during this phase can later be returned to Earth for thorough analysis. One of the key objectives of such a mission includes contributing to the preparation for human exploration of Mars, which includes constraining the nature of potential hazards [1].

The two main human health risk categories that drive the necessity for returned samples are engineering and biological/toxicological [2]. The engineering risks pertain to the terrain morphology of the landing operation zones (e.g. safe landing and human/rover locomotion) as well as possible mechanical failures due to environmental stressors. The biological and toxicological risks are broader in that they concern the health of both the explorers and life on Earth (e.g. back-contamination). Given the complexity of the hazards, the following sub-objectives were created. The foundation of each sub-objective is a thorough examination of the returned sample's physical features (e.g. grain size, shape) and bulk composition including: inorganic (e.g. bulk chemistry, mineralogy), organic, and biological. This is a provisional report from the iMOST Human Health Hazard Objective sub-team identifying key samples and techniques needed to understand the human hazards of martian surface exploration and possible ways to mitigate these risks.

Human Health Hazards Sub-objectives:

1. *Determine if biological hazards exist in the martian environments to be contacted by humans* that might have adverse effects on the crew if they were exposed while on Mars, and/or on other terrestrial species if uncontained martian material returned to Earth.

2. *Assess risks to crew health and performance* and inform the setting of appropriate permissible exposure limits by characterizing the potential acute and chronic toxicity resulting from exposure to martin dust.

3. *Characterize martian regolith and airfall samples in order to prepare high-fidelity martian regolith and dust simulants*. This includes, but is not limited to: understanding the major and minor differences in geochemistry that correlate with grain/particle size, shape, and aerodynamic diameter, as well as local versus global dust. The characterization of an array of samples will allow for the manufacturing of large quantities of simulants for use in engineering testbeds and large scale toxicological evaluations.

4. *Determine the efficacy of utilizing martian regolith as a radiation shield for humans on the surface from a solar particle event*. This would determine the types and quantity of radiation that can be shielded and the degree to which other biologically relevant particles are formed after passing through the substrate.

Recommended Samples: Although understanding the properties of drill core samples will inform engineering models and biological/toxicological hazard assessments, regolith and airfall samples will be the most valuable for initial determination of human health hazards. The two types of regolith samples required are: 1) bulk samples representative of "typical" surface material for the engineering models and 2) respirable (<10μm minimum; <2.5μm ideal) regolith and airfall samples for biological/toxicological evaluation. Furthermore, while not within the scope of the Mars 2020 mission, airfall samples will also be vital to assess the most likely human and mechanical exposure hazard.

References: [1] Beaty D. W. et al. (2018) *2nd Int. Mars Sample Return Conf.,* this volume. [2] NRC (National Research Council) (2002) *National Academies Press,* Int. Std. Book # 0-309-08426-1.