The Importance of Mars Samples in Constraining the Geological and Geophysical Processes on Mars and the Nature of its Crust, Mantle, and Core. iMOST Team (C.D.K. Herd[1], E. Ammannito, M. Anand, V. Debaille, L. J. Hallis, F. M. McCubbin, N. Schmitz, T. Usui, B. P. Weiss, and F. Altieri, Y. Amelin, D. W. Beaty, L. G. Bening, J. L. Bishop, L. E. Borg, D. Boucher, J. R. Brucato, H. Busemann, K. A. Campbell, B. L. Carrier, A. D. Czaja, D. J. Des Marais, M. Dixon, B. L. Ehlmann, J. D. Farmer, D. C. Fernandez-Remolar, J. Fogarty, D. P. Glavin, Y. S. Goreva, M. M. Grady, A. D. Harrington, E. M. Hausrath, B. Horgan, M. Humayan, T. Kleine, J. Kleinhenz, N. Mangold, R. Mackelprang, L. E. Mayhew, J. T. McCoy, S. M. McLennan, H. Y. McSween, D. E. Moser, F. Moynier, J. F. Mustard, P. B. Niles, G. G. Ori, F. Raulin, P. Rettberg, M. A. Rucker, D. L. Shuster, E. Sefton-Nash, M. A. Sephton, R. Shaheen, S. S. Siljestrom, C. L. Smith, J. A. Spry, A. Steele, T. D. Swindle, N. J. Tosca, M. J. Van Kranendonk, M. Wadhwa, S. C. Werner, F. Westall, R. M. Wheeler, J. Zipfel, M. P. Zorzano) [1]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Canada, herd@ualberta.ca.

Introduction: *In situ* compositional and mineralogical measurements on the Martian surface, combined with analyses of Martian meteorites, indicate that most igneous rocks are lavas and volcaniclastic rocks of basaltic composition and cumulates of ultramafic composition [1]. Alkaline rocks are common in Early Hesperian terranes and tholeiitic rocks dominate younger Amazonian martian meteorites [1]. Very uncommon feldspathic rocks represent the ultimate fractionation products, while granitoid rocks have not been identified [1]. The impact-driven delivery mechanism for the Martian meteorites [2] biases in favor of more competent samples – young, igneous rocks [e.g., 3] – and against rocks that are more representative of the Martian crust [e.g., 4]. Comparisons of rock types found among the meteorites to those documented by landed missions demonstrates this bias unequivocally [1]; furthermore, of the over 100 martian lithologies represented by the martian meteorites, only one (NWA 7034 and pairs) is a regolith breccia [e.g., 1, 5].

While the meteorites provide important insights into the nature of the silicate portion of Mars, including the origin of mantle components with differing geochemical characteristics [e.g., 6], they do not provide information on the composition of the original crust Mars, nor the nature of the mantle sources from which rocks at the Martian surface have been derived (e.g., igneous rocks at Gusev and Gale craters). Thus, there is much to be learned from the study of carefully selected samples from the martian surface.

Sub-Objectives (in no priority order) for any potential MSR landing site:

a) Determine the diversity of igneous rocks and the mechanisms for that diversity; the relationship of those rocks to other igneous rocks of Mars; and the makeup of breccias.
b) Determine the long-term production of igneous liquids on Mars, and use this to quantitatively constrain the composition and evolution of the martian mantle
c) Constrain the long-term geodynamical evolution of Mars, from core segregation to crustal differentiation, and the existence of chemically distinct mantle reservoirs
d) Determine the nature of the early martian crust, and the processes that caused its early alteration to form widespread hydrous minerals
e) Improve our understanding of cratering as a process for modifying the martian surface, including the development of shock-related rocks and mineral assemblages, impact-induced melts, impact-related hydrothermal alteration, and impact-deposited sediments
f) Constrain the processes that lead to weathering, erosion, transport, deposition, and lithification of sedimentary rocks on Mars
g) Constrain the composition, physical properties, and origin of globally transported martian dust
h) Constrain the strength and orientation of the ancient martian magnetic field

Samples: Addressing this objective requires samples that record igneous compositional diversity (in major, minor and trace elements and isotopes) reflecting differences in mantle source characteristics and/or igneous fractionation processes; samples that capture the nature of the processes that formed and affected the primitive crust of Mars; samples that provide insights into the nature of cratering on Mars; and samples that constrain the processes of weathering, transport and deposition of older rocks to form younger sediments (including global dust) and sedimentary rocks. This objective also requires oriented samples which record the evolution of the Martian dynamo.

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