SEEKING SIGNS OF LIFE ON MARS: A STRATEGY FOR SELECTING AND ANALYZING RETURNED SAMPLES FROM HYDROTHERMAL DEPOSITS. iMOST Team (K. A. Campbell[1], J. D. Farmer, M. J. Van Kranendonk, D. C. Fernandez-Remolar, A. D. Czaja, and 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, B. L. Carrier, V. Debaille, D. J. Des Marais, M. Dixon, B. L. Ehlmann , J. Fogarty, D. P. Glavin, Y. S. Goreva, M. M. Grady, L. J. Hallis, A. D. Harrington, 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, 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, N. Schmitz, E. Sefton-Nash, M. A. Sephton, R. Shaheen, D. L. Shuster, S. Siljeström, C. L. Smith, J. A. Spry, A. Steele, T. D. Swindle, I. L. ten Kate, N. J. Tosca, T. Usui, M. Wadhwa, B. P. Weiss, S. C. Werner, F. Westall, R. M. Wheeler, J. Zipfel, M. P. Zorzano)
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Introduction: Highly promising locales for biosignature prospecting on Mars are ancient hydrothermal deposits, formed by the interaction of surface water with heat from volcanism or impacts [1-3]. On Earth, they occur throughout the geological record (to at least ~3.5 Ga), preserving robust mineralogical, textural and compositional evidence of thermophilic microbial activity [e.g., 3-5]. Hydrothermal systems were likely present early in Mars' history [6], including at two of the three finalist candidate landing sites for M2020, Columbia Hills [7-9] and NE Syrtis Major [10 & refs. therein]. Hydrothermal environments on Earth's surface are varied, constituting subaerial hot spring aprons, mounds and fumaroles; shallow to deep-sea hydrothermal vents (black and white smokers); and vent mounds and hot-spring discharges in lacustrine and fluvial settings. Biological information can be preserved by rapid, spring-sourced mineral precipitation [1,2,9], but also could be altered or destroyed by post-depositional events [5,11,12]. Thus, field observations need to be followed by detailed laboratory analysis to verify potential biosignatures.

Selection of Cached Samples: Exploration of a Martian hydrothermal deposit for signs of past life requires establishment of geologic context, identification of constraints on past habitability, and assessment of potential for biosignature capture and preservation [13]. Utilization of a spatially integrated framework of overlapping orbital, to outcrop, to micro- and geochemical scale observations, and application of predictive facies models from Earth-analog hydrothermal systems, will optimize selection of cached samples that are most likely to yield biosignature information in subsequent Earth-based laboratory investigations.

Key Samples and Investigations: The iMOST hydrothermal deposits sub-team (within the Seeking the Signs of Life Objective for a possible MSR campaign) has identified key samples and investigations required to delineate the character and preservational state of potential biosignatures, thus paving the way to ultimately confirm their essential nature as either abiological or biological in origin. Returned samples would ideally include representative examples of primary hydrothermal facies formed by cooling and degassing of discharge fluids away from vent-point sources, in which variably adapted microbial components would be expected. Such samples, selected from rover mapping of lateral/vertical facies distributions and spectral identification of hydrothermal sediments, would be subjected to Earth-based textural, mineralogical, elemental and isotopic analyses to potentially reveal thermal gradients, flow rates, duration of thermal outflow, and evolution of the hydrothermal system over time, including reconstruction of a fluid history that may have affected the types, as well as quality of preservation of biosignatures. Returned samples would also enable lab tests for consistency with biotic processes, via microscale mapping and study of bioessential elements/minerals; measurement of mineral and isotopic proxies involved in redox coupling relevant to biogeochemical cycling; and high-resolution interrogation of oxidized and reduced carbon by methods only available in Earth-based laboratories.

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