MARTIAN BRINES IN ANCIENT SALT LAKE BEDS – A HIGH PRIORITY TARGET FOR MARS SAMPLE RETURN. M. Fries[1], A. Steele[2], and M. Zolensky[1], [1]NASA Astromaterials Research and Exploration Science (ARES), Johnson Space Center, Houston, TX. [2]Earth and Planets Laboratory, Carnegie Institution for Science, Washington D.C. Email: marc.d.fries@nasa.gov

Introduction: Mars hosts over 600 chloride deposits as identified from orbital imagery [1-3], including deposits in settings resembling dry, evaporite lacustrine bedforms on Earth. A Mars sample return mission to one of these salt lake beds has a strong potential to directly sample present-day brines originating from ancient martian surface fluids, allowing direct laboratory investigation into fluids, atmosphere, and either potential biology or prebiological conditions on the martian surface at the Noachian through the Hesperian epochs. These sites are extraordinarily well suited for sample return missions because they are favorable for landing and for drill-based sampling, and preserve samples of parent water bodies, including dissolved atmosphere and potential well-preserved biological remains. Such a mission would provide a foundational set of reference samples for understanding Mars' physiochemical and pre-/biological history, likely to be investigated in depth for generations to come.

Science Return from Chloride Lacustrine Settings: Evaporite salt deposits are noted for their extremely favorable preservation of ancient organics [4,5]. The parent fluid from which they precipitated can also be preserved. For example, halite grains discovered in the Zag and Monahans meteorites contain 4.5 Ga-old organics and parent brine [6]. The strong possibility exists that samples of the ancient martian atmosphere may be present in fluid inclusions as well, allowing direct analysis [7]. It is reasonable to expect that chloride salts at or very near the surface of martian lake bed deposits retain samples of their parent fluid and any organics present from the time when the lakes evaporated, which has been dated to the Noachian and Hesperian [2]. In terrestrial examples, halite has been shown to preserve ancient microbes as well, although the age of these microbes most reliably extends into the 100 ka range [8] and may not reliably preserve potential martian microbes dating from Hesperian ages. If a modern-day microbiome exists in the martian salt flat settings, however, it may be directly sampled. Samples collected from martian lake bed(s) would directly address the hypothesis of martian life present in the end stages of purported surface water. It would also collect material with some of the best preservation potential available (salts and other evaporites), which is present at or very near the surface.

Landing and Sampling: Lake bed settings can be especially well suited for spacecraft landing sites. On Earth, lake beds in the American west have been favored sites for automotive high speed testing (e.g. Bonneville Salt Flats, UT) and airfields (e.g. Edwards AFB, CA) because of their broad expanses of level, compacted ground. Lacustrine evaporite flats also feature relatively homogenous mineralogy across broad areas. This simplifies the task of sampling because small, precise landing ellipses are not strictly necessary, and landed mobility is probably not necessary either. Martian lacustrine settings are favorable for relatively straightforward "grab and go" sampling with a high likelihood that a prescribed set of evaporite and sediment samples can be reliably collected. The mineralogy of these settings also tends to favor drilling, as relatively friable evaporite and sedimentary minerals dominate. Overall, risks involved in both landing and sampling are reduced.

Summary: Martian chloride deposits should be considered a prime science target for future sample return mission(s). Evaporite lake beds are known from terrestrial examples to feature broad, flat expanses of nearly homogenous mineralogy. That mineralogy is composed of materials with superb organic and microbiological preservation potential which are exposed at the surface. Sampling risks are reduced because high science value target materials are widespread, reducing the need for landing accuracy and obviating the need for mobility. The samples collected date from the period when martian surface fluids evaporated from the surface, which has been identified as a science priority [e.g. 5,9,10,11,12].

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