MARTIAN HALITE: POTENTIAL FOR BOTH LONG-TERM PRESERVATION OF ORGANICS AND A SOURCE OF WATER

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Summary: Deposits containing halite on Mars are both rich scientific targets and potentially a resource for manned Mars exploration. Halite on earth exhibits excellent preservation potential for organics. The entrainment of organics occurs through a relatively low energy evaporative process. Therefore deposits on Mars are excellent materials to search for evidence of ancient martian organics. Halite also tends to entrain a portion of its parent brine, potentially storing a quantity of water for resource utilization. Halite-bearing deposits have been identified in ~640 locales throughout the southern highlands of Mars [1], presenting surface-accessible science and resource utilization targets. The intent of this abstract is to discuss the science and resource ROI potential for manned landing sites in general, without singling out a specific site to suggest as a landing site.

Science Potential: Identifying ancient martian organic species is a very important aspect of the search for ancient martian life. Also, understanding the geochemistry of the ancient martian water would allow for a better assessment of past habitability for a given site. Halite is of special interest in these pursuits because it can preserve organics for extraordinary lengths of time. Terrestrial halite deposits are known to preserve organics to include carbonaceous solids, gases, and petroleum liquids for time scales in the range of hundreds of millions of years [2,3]. Tectonic activity and terrestrial aqueous processing, however, limit the survival of terrestrial halite deposits. Halites can preserve organics much longer in dry, tectonically stable extraterrestrial settings as seen in ~4.3-4.5 Ga old, organics- and water-bearing halite found in the Zag and Monahans meteorites [4-7]. Based on crater age-dating results from [8,9] halite deposits on Mars date from the late Noachian to early Hesperian and correspond in time with the end of widespread surface water activity on the planet. As such the halite-bearing deposits may contain organics dating from that time period.

Halite has exceptional potential for preserving organics because it protects entrained carbonaceous material from martian surficial oxidants such as perchlorates as long as the halite remains intact. The entrained carbonaceous material would still undergo alteration due to ambient radiation exposure, but radiation damage does not remove carbon from the halite interior. This is shown in halites from Zag and Monahans meteorites, which have been irradiated to a blue/purple color over an extended exposure residence in an asteroidal regolith (Figure 1) but which retain ancient brine, carbonaceous solids and aliphatic compounds [4-7].

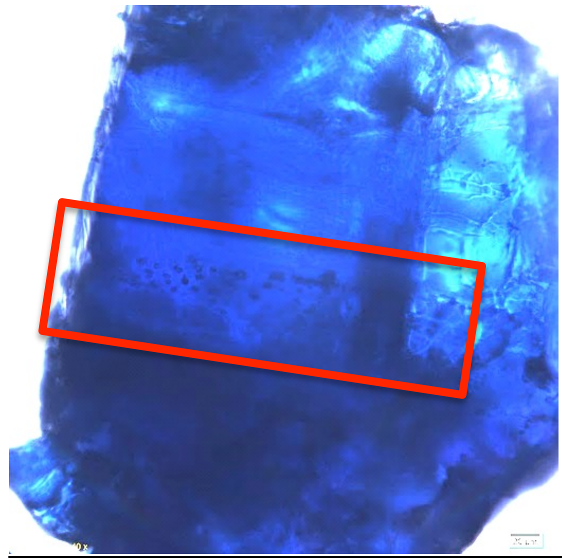

Figure 1: A 4.3-4.5 Ga old halite grain from the Zag meteorite. The blue color is a consequence of radiation damage. The red box highlights a chain of brine-bearing fluid inclusions in the halite, preserving 4.3-4.5 Ga water from the parent body. Scale bar is 20 μm long.

Resource Potential: Halite tends to trap a small amount of its parent brine as it solidifies (e.g. Figure 1). This suggests that martian halite deposits may contain a component of ancient martian water. From a human exploration standpoint, martian halite deposits might be a surface-accessible source of a useful amount of water for future manned missions. Halite is regularly mined on Earth and is amenable to extraction of entrained water. The amount of water present depends on the amount entrained during deposition and on survival factors to include exposure to heat, shock, and aqueous processing since the halite was originally deposited.

Halite Deposits on Mars: Previous work using the Thermal Emission Imaging System (THEMIS) has identified ~640 chloride-bearing deposits on the martian surface, mostly in the southern hemisphere (Figure 2)[1] and within Noachian- and Hesperian-aged terrains. Spectroscopic observations using THEMIS and higher spectral resolution data from the Thermal Emis-

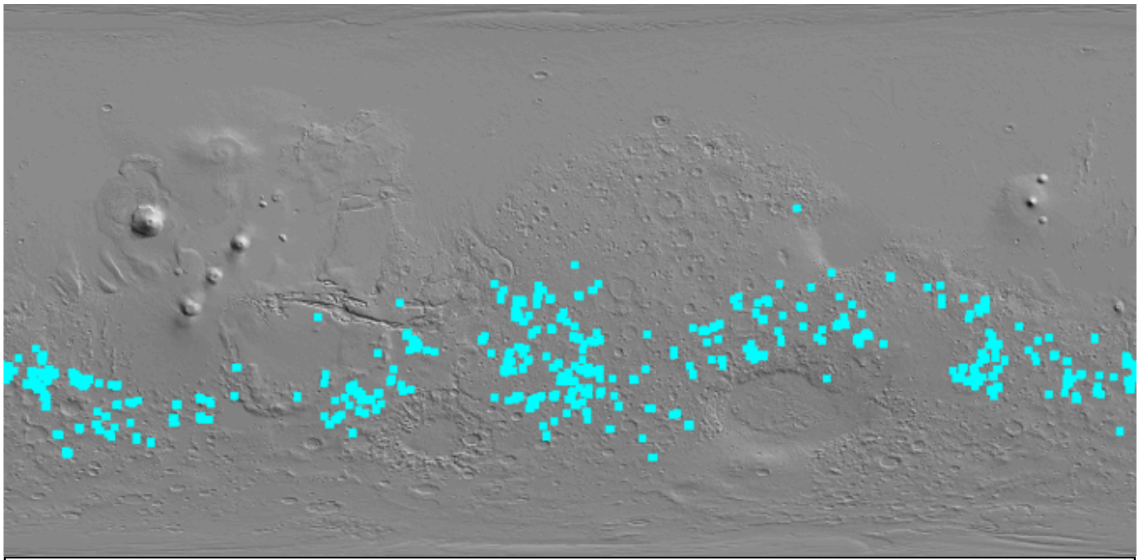

Figure 2: Global Mars elevation map indicating the locations of chloride deposits (blue squares) identified to date (see [1]). The blue squares are enlarged relative to the areal extent of the deposits for ease of viewing.

sion Spectrometer (TES) as well as visible to near-infrared data from the Compact Reconnonaissance Imaging Spectrometer for Mars (CRISM) indicate the best spectral matches to the martian material include a mixture of an anhydrous chloride salt (i.e., halite) and silicates [9-11]. Geologic investigations indicate that most geomorphological observations are consistent with formation by ponding of surface water runoff and evaporation, although formation by hydrothermal processes or efflorescence may have occurred in some locales [1,8,9].Additionally, given the overlap in the ages of the martian halite deposits with the ages of the valley networks, it is possible that these materials represent the last vestiges of surface water activity on the planet [8].

References: [1] Osterloo M., Anderson F., Hamilton V., Hynek B., JGR 115 (2010) E10012. [2] Melvin J., ed., Evaporites, Petroleum and Mineral Resources (1991). [3] Schoenherr J. et al, Geo. Res. Abstracts 7 (2005). [4] Zolensky M. et al, *Workshop on the Potential for Finding Life in a Europa Plume* (2015) Abstract #3004. [5] Fries M., Steele A. and Hynek B., 46th LPSC (2105) Abstract #3017. [6] Fries M. Messenger S., Steele A., Zolensky M., *Workshop on Habitability of Icy Worlds*, (2013) Abstract #4078. [7] Fries M., Messenger S., Steele A., Zolensky M., 76th MetSoc (2013) Abstract #5266. [8] Osterloo M. and Hynek B., 46th LPSC (2015) Abstract #1054. [9] Osterloo M., et al *Science* 319 (2008) p. 1651-1654. [10] Glotch, T. D. et al. 44th LPSC (2013) Abstract #1549, [11] Jensen, H. and Glotch T. D., JGR 116 E00J03 (2011).