HALITE AS A METHANE SEQUESTRATION HOST: A POSSIBLE EXPLANATION FOR PERIODIC METHANE RELEASE ON MARS, AND A SURFACE-ACCESSIBLE SOURCE OF ANCIENT MARTIAN CARBON. Fries M.D.[1] Andrew Steele[2] and Hynek B.M.[2], [1]NASA Johnson Space Center, Astromaterials Acquisition and Curation Office, Houston, TX, [2]Geophysical Laboratory, Carnegie Institution for Science, Washington DC. [3]Laboratory for Atmospheric and Space Physics, University of Colorado-Boulder, 3665 Discover Drive, Boulder, CO 80303, 2Dept. of Geological Sciences, University of Colorado-Boulder. Email:marc.d.fries@nasa.gov

Introduction: We present the hypothesis that halite may play a role in methane sequestration on the martian surface. In terrestrial examples, halite deposits sequester large volumes of methane and chloromethane. Also, examples of chloromethane-bearing, ~4.5 Ga old halite from the Monahans meteorite show that this system is very stable unless the halite is damaged. On Mars, methane may be generated from carbonaceous material trapped in ancient halite deposits and sequestered. The methane may be released by damaging its halite host; either by aqueous alteration, aeolian abrasion, heating, or impact shock. Such a scenario may help to explain the appearance of short-lived releases of methane on the martian surface [1]. The methane may be of either biogenic or abiogenic origin. If this scenario plays a significant role on Mars, then martian halite deposits may contain samples of organic compounds dating to the ancient desiccation of the planet, accessible at the surface for future sample return missions.

Halite as a Methane Sequestration Host in Terrestrial Settings: Halite is known to host methane and/or chloromethane in a wide variety of terrestrial sites. Chloromethane escaping from salt beds in the Aral Sea has been observed by remote sensing [4]. Methane has also been noted in halite deposits in Gabon [5], subterranean deposits in East Siberia [6], Poland [7], and elsewhere. Chloromethane was also found in halite of ~4.5 Ga age in the Monahans meteorite, demonstrating the stability of halite as a methane sequestration host [8].

Methane is commonly present in fluid inclusions in halite, and evidence from the Monahans meteorite suggests that chloromethane forms as methane dissolves in the halite (Figure 2). The methane may arise from carbonaceous inclusions entrained in the halite, perhaps arising from UV irradiation as has been demonstrated with the Murchison meteorite [9]. Methane may also be added to halite deposits via the formation of secondary fluid inclusions.

Release Mechanisms: Once entrained in halite, methane can be released by damaging the halite host. There are four major ways this can occur:

Aqueous Alteration: Halite is susceptible to dissolution in aqueous solution.

Aeolian Abrasion: Halite outcrops can release methane upon mechanical wear.

Heating: If the methane is entrained in fluid inclusions, the fluids will migrate by dissolving and re-precipitating their surrounding matrix. This effect becomes significant at only ~25°C [10], so subterranean thermal events of modest magnitude might contribute to this release mode.

Impact/Shock: Mechanical damage can release methane from halite fluid inclusions. Halite is a brittle material of low strength, but such a mechanism obviously has to be combined with an impact event.

Implications: If halite plays a significant role in sequestering methane on Mars, then the following implications arise (among others):

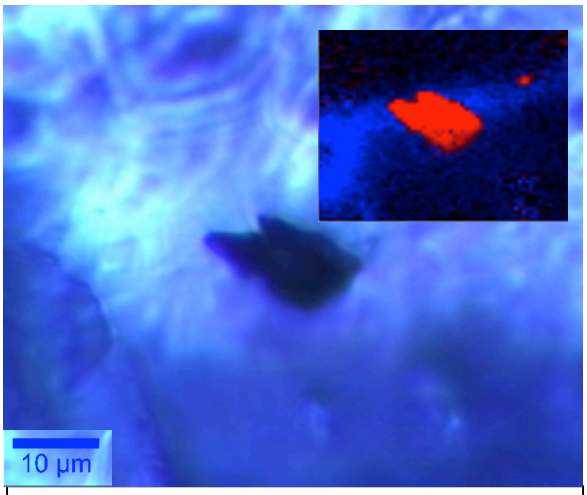

Figure 2: Chloromethane preserved in ~4.5 Ga halite in the Monahans meteorite. Large image: Transmitted light image of a carbonaceous inclusion in the halite. Inset: Raman image of macromolecular carbon (Red) and chloromethane (Blue). Chloromethane is dissolved in the halite matrix. From [8].

- The methane detected by remote observation and MSL rover may have an ancient source.
- The methane may arise from a near-surface source, perhaps massive halite deposits noted by remote sensing imagery. Such material may be available at the surface for future Mars sample return.

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