HYPERSALINE AND SEDIMENTOLOGICAL ADVANTAGES ON THE PRESERVATION OF EXTANT BIOLOGICAL ACTIVITY IN MODERN MARTIAN ANALOGUE SETTINGS

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Introduction: An independent origin and evolution [1] for potential microorganisms on Mars may present significant differences in macromolecular structures, prebiotic chemistries, and timelines that we have observed on Earth. If life evolved to the point of utilizing cellular structures for macromolecule compartmentalization, the ability for those organisms to adapt to the changing Martian climate including desiccation and UV damage would be significantly increased. Evidence of these adaptations are found through extreme environments on Earth, specifically in hypersaline settings where liquid water is present.

Motivation: Under slow-changing environmental conditions, modern terrestrial microbial life has the ability to respond to ecological stresses and employ survival strategies. Halophilic microorganisms contain stable intracellular proteins that function within high molar concentrations [2,3] of NaCl and other salts typically associated with evaporite mineralogy.

From orbit, MRO/CRISM has observed hydrated minerals including sulfate salts, phyllosilicate clays, and carbonates [4] while on the surface. Additionally, rovers have observed box work structures indicative of sulfate mineral veins and secondary pores [5] that suggest halite. Groundwater downwelling may have allowed for evaporites to have been precipitated away from the ultraviolet (UV) radiation and desiccation that characterizes the Martian surface since the early Hesperian.

The purpose of this work is twofold. First, we will show how preserved water activity within evaporite minerals found in Martian analogue environments can sustain ongoing metabolic processes from halophilic bacteria and archaea. Second, we will hypothesize Martian shallow subsurface conditions in which microbiology on Earth has a foothold in specific hypersaline extreme environments that emulate both ancient and modern conditions.

Microbial Diversity in the Great Salt Lake (GSL): GSL as a modern hypersaline system surrounded by deposits of evaporite minerals. Microbial life is prevalent and diverse in the water column as well as in fluid inclusions of halite and gypsum [3] (Fig. 1). The halophilic microorganisms have evolved to live at low water activity (a_w), balancing osmotically by the accumulation of compatible solutes and potassium ions. Gypsum with embedded clays preserve higher ng/µl amounts of DNA alongside halite with fluid inclusions that allow for the preservation and continuation of microbial metabolisms (Fig 3, [3]). Halophilic archaea have an arsenal of UV protective strategies and DNA repair (Fig. 2), also the ability to resist desiccation [6,7].

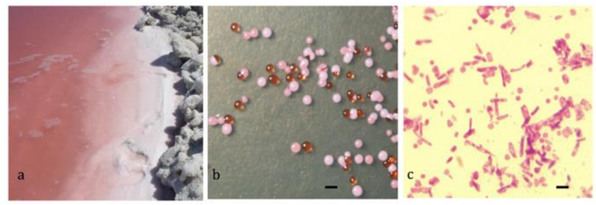

Fig. 1. (Left) GSL arm water at the shoreline; **(Center)** Halophilic archaeal and bacterial colonies on solid media, scale bar = 1 mm. **(Right)** Light micrograph of a stained slide of north arm water, scale bar = 1 µm.

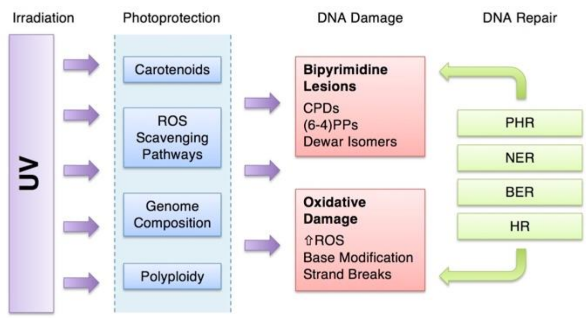

Fig. 2. Adapted from [6] showing photoprotection and DNA repair pathways of halophilic archaea.

Fig. 3. Evaporite minerals found in our field sites and observed in outcrops and globally in hydrated minerals across Mars [4]

References: [1] Hug et al. (2016) doi: 10.1038 *Nature Microbiology*. [2] Ebel & Zaccai, (2004) *J Mol Recognit. 17(5):382-9.* [3] Perl S.M. et al. (2018, submitted) [4] Ehlmann & Edwards (2014) *Ann. Rev. of Earth and Planetary Sci 42(1):291-315*. [5] Perl et al. (2007) *7th International Conf. on Mars* [6] Jones & Baxter (2017) *Front. Microbio*. 8:1882. [7] Baxter & Zalar (2019, in press). *Mod. Ecosys. in Ext. Env. Environments*, eds Seckbach & Rampelotto.