DELIQUESCENCE-BASED HABITABILITY AND THE SEARCH FOR LIFE ON MARS A. Davila, NASA Ames Research Center, MS 245-3, Moffett Field CA 94035 (alfonso.davila@nasa.gov)

Introduction: The search for evidence of life on the surface of Mars relies on the discovery of past habitable environments—locations with liquid water, sources of essential elements (CHNOPS) and energy, and adequate physical and chemical conditions. A subset of possible habitable environments includes *land* habitats, where organisms rely on atmospheric sources of water (e.g. rain, snow), and in light or chemical redox couples as sources of energy. Land habitats on Mars are of interest because they could have been the last outposts of a vanishing martian biosphere, long after the disappearance of aquatic habitats [1].

Even amongst land habitats there is a continuum in habitability potential, and some land habitats can support larger biological diversity than others [2,3]. On Earth, the end of this continuum is found in the driest regions, such as the hyperarid core of the Atacama Desert. Here, only the deliquescence of salt substrates can still provide sufficient liquid water, episodically, to sustain a complete microbial community with primary producers and consumers [4,5]. By analogy, the last locations for life near the surface of Mars might have been deliquescent substrates.

The timing of deliquescence-based habitability on Mars: Deliquescence-based habitability depends, among other factors (discussed below) on the abundance of water in the atmosphere. To a first approximation, the water abundance in the present-day martian atmosphere is lower than in the driest regions on Earth by a factor of 10–100, but during high obliquity locally it can reach levels comparable to those measured in the hyperarid core of the Atacama Desert and over the Antarctic plateau, near the south pole. Assuming that the driest parts of the Atacama Desert fall close to the dry limit of habitability [6], water abundance in the martian atmosphere might have been compatible with deliquescence-based habitats until relatively recently, perhaps during the late Amazonian.

Deliquescence-based habitats on Mars: Because large salt deposits have been found on the surface of Mars [7], and deliquescence has been considered as a possible source of water to explain certain modern morphological features [8], the possibility of deliquescence-based habitats on Mars has received increasing attention. However, habitability must be understood as a multidimensional space defined by parameters other than the presence of liquid water. Of those parameters, physical and chemical conditions and energy demands play a significant role, particularly in environments at the fringe of habitability.

Physical and chemical constrains on deliquescence-based habitability: Deliquescence invariably results in saturated brines. Some saturated brines are deadly to organisms because they destabilize biomolecules, examples include saturated brines of chaotropic salts such as MgCl2, CaCl2, or (per)chlorates.

Energy demands: Microbial communities that rely on meager and stochastic sources of water such as deliquescence can only endure if the community sustains a long-term net positive carbon balance [9] Repeated cycles of wetting and drying impose severe energetic demands on the community, and this can prove deadly in the long term unless the communities can balance respiration with carbon fixation.

Widespread deposits with a chloride salt component in the southern hemisphere of Mars could be an example of deliquescence-based habitats [10]. However, a proper assessment of the habitability potential of such deposits cannot be done until the exact composition of the deposits is known, particularly with respect to the dominant type of salt.

Conclusions: The last possible sources of water for life on Mars might have been the deliquescence of hygroscopic salts. But habitability in water-limited environments critically depends on the physical and chemical conditions, and the energy demands imposed by repeated wet/dry cycles. More compositional and climatic data are required to determine if salt deposits on Mars could be sites of recent habitability.

References:

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