ICE MELTING BY RADIANTLY HEATED DUST GRAINS ON THE MARTIAN NORTHERN POLE.

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Introduction: Recently, extensive gypsum deposits have been discovered in the Circumpolar Dune Field and on the Martian Northern Ice Cap (MNIC) [1,2,3]. One of the proposed mechanisms of their formation is by weathering within ice [4,5,6], however none of the previous studies have checked if this process is possible under current Martian conditions. Studies of Martian evaporitic minerals are crucial for constraining characteristics of the aqueous fluids, both past and present, on the surface of the Red Planet. This is especially important because areas of evaporitic mineral formation may be among the most hospitable environments on Mars [7,8].

The aim of this paper is to numerically model if the weathering of dust grains within the MNIC is possible under current Martian conditions in order to explain the existence of extensive gypsum deposits at Meridiani Planum. To test this hypothesis, we check if radiant heating is sufficient to melt a thin layer of ice surrounding a single dust grain exposed within the south-facing side of the MNIC spiral trench.

Methods: We model a single basaltic dust grain (2-200 µm in diameter) lying on glacial ice that is mixed with dust, exposed within a spiral trough of the MNIC and heated by solar irradiance during the warmest days of the summer. We assume that the surface of the grain is inclined so that solar rays are perpendicular to the surface of the grain at noon. To describe this process, we developed a 2D numerical model based on the equation of heat transfer (see [9] for more details):

Results: Depending on the local solar constant, grain emissivity and thermal conductivity of ice, ice surrounding the dust grain melt for up to few hours a day during the warmest days of summer. For example, for solar constant 350 W/m2, emissivity 0.80, grain size 2 um, and thermal conductivity 0.4 W/mK melting lasts for ~300 minutes and result in melting of 6 mm of ice.

Discussion: Average surface pressure during summer on the MNIC is ~660-760 Pa; slightly above the triple point. During the windless days conditions next to the surface of the ice should allow for liquid water to be stable for significant amount of time. The interaction of the dust particles with small amounts of liquid water could lead to formation of evaporitic minerals, similar to evaporates formed on terrestrial, Antarctic meteorites [10].

References: References: [1] Langevin et al. 2005, Icarus 144: 456-462. [2] Horgan et al. 2009, *J. Geoph. Res. Planets* 114: 1-27. [3] Masse et al. 2012, *Earth Planet. Sci. Lett.* 317-318: 44-55. [4] Catling et al. 2006, *Icarus* 181: 26-51. [5] Zolotov & Mironenko 2007, *J. Geoph. Res. Planets* 112, doi:10.1029/2006JE002882. [6] Niles & Michalski 2009, *Nature Geoscience* 2: 215-220. [7] Horneck 2000, *Planet Space Sci. Lett.* 48:1053–1063. [8] Benison & LaClair 2003, *Astrobiology* 3: 609-618. [9] Czechowski 2012, *Acta Geophys.* 60: 1192-1212. [10] Losiak & Velbel 2011 *MAPS* 46:443–458.