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Ephemeral Liquid Water at the Surface of Martian North Polar Cap

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Formation of large, young gypsum deposits within the Olympia Planum region has been an unsolved riddle since its discovery [1]. It was proposed that gypsum was formed by precipitation of water emanating from polar layered deposits [2]. However, it is improbable that a large amount of bulk water could exist under current Martian low atmospheric pressure sufficiently long to form the observed deposits [3]. One of the proposed solutions to this problem is that gypsum is formed due to weathering in the ice [3, 4, 5, 6]. However none of the previous papers have described this process in detail, tested whether it is possible under current Martian conditions, and defined the environmental properties required for this process to occur.

The aim of this paper is to determine if solar irradiation available currently at the North Polar Cap (NPC) is sufficient to heat a basaltic dust grain enough to melt a thin layer of glacial ice located directly beneath it. The numerical model used here is based on a one dimensional, time-dependent equation of heat transfer [8]. The model is applicable for grains exposed on the south-facing side of the NPC spiral troughs, during the warmest days of the year (with average or low amount of dust in the atmosphere), when surface temperature reaches 215 K and solar radiation delivers >260 W m̂-2 (on the inclined surface).

Our calculations show that during the warmest days of summer, pure water-ice located below a dark dust particle lying on the equatorial-facing slopes of the Martian NPC can be melted. Melting occurs over a wide range of used parameters which shows that this phenomenon is relatively common (albeit localized).

Our research shows that on the Martian NPC there can be a sufficient amount of transient, metastable liquid water for evaporites such as gypsum to form, as was hypothesized by [3, 4, 5, 6]. Additionally, bulk water surrounding dust grains near the surface and precipitating evaporitic minerals makes the NPC one of the most potentially habitable environments on Mars.

References:

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