MELTING OF POLAR MARTIAN ICE BENEATH WARmed BASALTIC Dune Sands. I. Lawrence1, S. L. Pérez-Cortés2, M. D. Day1, A. M. Bramson2, 1University of California, Los Angeles, Department of Earth, Planetary and Space Sciences, CA (ilawren@g.ucla.edu), 2 Purdue University, West Lafayette, IN.

Introduction: On Mars, aeolian processes shape the landscape in the equatorial and mid-latitude regions, and cryo-processes dominate the poles [1]. The intersections between polar- and aeolian processes leave behind unique surface morphologies not observed on other planets or other regions of Mars. For example, dunes superimposed on polar ice occasionally form in association with shallow pits in the ice that contain interior lineations (Fig. 1). The pits form at scales similar to barchan dunes (~100’s of m), with lineations several meters thick that can be resolved in images from the High Resolution Imaging Science Experiment (HiRISE) camera [2]. These lineations, similar in morphology to basal cross strata from barchan dunes, likely reflect the interaction between the nearby dunes and the underlying ice. How do these shallow pits form? Are dunes melting the ice in place? Is the ice accumulating around small polar dunes? In this work, we investigate how ice and wind interact to form these unusual martian features.

Hypothesis: We aim to test the hypothesis that basaltic sands on Mars, warmed by the sun, could create enough basal heat to melt underlying water or CO2 ice. Such melting, whether possible in present or past martian conditions, could have temporarily produced liquid water available for microbial life. In combination with the radiation protection provided by overlying dune sand, and the potential nutrient source on mineral surfaces, warmed basal dunes could have represented a habitable microclimate.

Methods: To test how warming of martian sands may translate to basal ice, we apply a thermodynamic model previously used on Earth [3] and adjust the boundary conditions for appropriate application to Mars [4]. We begin with a 1D model of heat transfer through a vertical column of sand, and represent the cross section of a dune in 2D with stacked 1D models. From here, we expand the approach to include lateral heat transfer and create a 2D model of the dune in cross section. We assume that lateral heat transfer from stoss to lee dominates over lateral heat transfer along-crest (or is at worst similarly important) and, therefore, only model the dune in cross section.

Results: The results of this exploratory model are actively developing, but suggest that under rare present or more common past martian conditions, solar radiation could have heated basalt sands to the point of causing sublimation in polar CO2 ice. Increases in solar incident energy associated with high obliquity phases of martian history make basal melting more likely. The time needed to induce basal warming is less than, in some cases, the diurnal fluctuations in temperature, suggesting that any melting may be short-lived and/or repeated daily. Additional testing and development of the thermal model is needed to test the sensitivity of the input assumptions and the limits of the model applicability. At this preliminary stage, our work suggests that the proposed hypothesis is possible in some conditions.

Figure 1: Lineations in shallow depressions of Mars polar ice associated with nearby barchan dunes of similar size. North is up. HiRISE image ESP_054866_2615.

Acknowledgments: This work was made possible by images from the HiRISE instrument, archived on the HiRISE Team website and at the PDS.