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MOLARDS ON MARS AND MERCURY: SIGNS OF VOLATILE LOSS

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Introduction: Molards are cones of debris that result from the disaggregation of ice-cemented blocks transported by mass movements [1,2] (Figure 1). Recently, we linked the origin of molards directly to permafrost degradation on Earth [3]. Permafrost conditions are a pre-requisite for forming the ice cement within the blocks, and its subsequent degradation triggers the mass movement leading to the formation of the final molards. In [3], we show that molards are recognisable in remote sensing data. In addition, we report that the distribution and morphology of molards give insights into landslide dynamics. This new terrestrial work led us to search for such landforms on other planets where the role of volatiles in landscape evolution is under debate. Volatiles are substances that easily change phase, for this work we refer to ices and solids (H_2O , CO_2 , N_2 , S, Cl) becoming gas or liquid. Our preliminary work has revealed molard-like landforms on Mars and on Mercury related with impact craters.

Mars - Hale Crater: Candidate molards are found in the ejecta flows of the one billion year old Hale Crater, which are similar in morphology and spatial distribution to molards found in the Mount Meager debris-avalanche deposits on Earth [5] (Figure 1). Hale impact has already been proposed to have occurred into ice-rich materials [6] and hence it is not unlikely that the ejecta may also have contained ice. The presence of molards suggests that not all the ice was melted by the impact and that the ice itself was contained within the pores of the soil, ra-

ther than massive sheets of glacial ice. In future work we aim to constrain both the initial ground ice content at the Hale impact, but also the conditions during ejecta emplacement.

Mercury - Caloris Ejecta: Conical mounds are found around the Caloris Basin on Mercury. We mapped their locations and found that their distribution is consistent with them being part of the Caloris ejecta blanket. Their shape and the fact that debris from their flanks buries surrounding materials (Figure 1) suggests they continued to evolve long after the basin was formed. Because their flank-slopes and shapes are similar to molards on Earth we suggest a similar formation via volatile loss. In the last few years Mercury has been revealed to be much more volatile-rich than previously thought [e.g. 4], and our discovery of candidate molards in the ejecta of the Caloris Basin suggests that the crust and mantle has been enriched in volatiles since the basin formed ~3.8 billion years ago.

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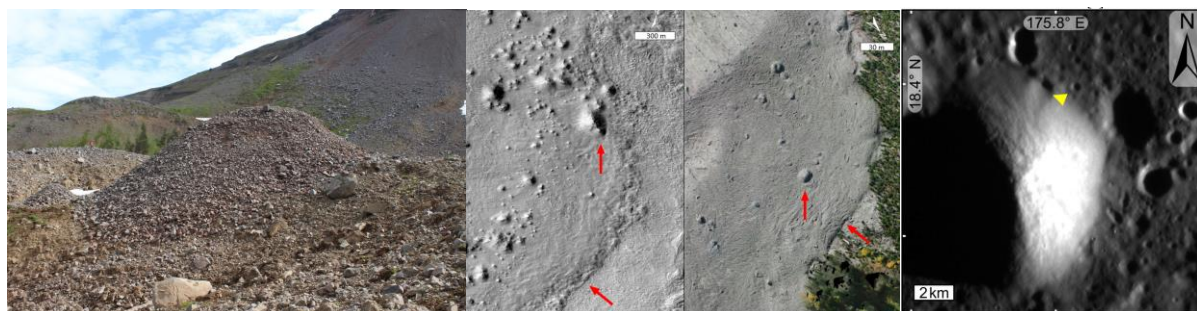


Figure 1. Left to right: A molard in the Móafellshyrna landslide, which occurred in 2012, height ~20 m. Planview comparison between candidate molards in Hale crater ejecta, and molards in the landslide deposits at the foot of Mount Meager, where red arrows indicate similar features (flow boundary and molards embedded in flow deposits). Conical knob on Mercury where the yellow arrow indicates crater on Caloris Planitia partially obscured by knob material and a subtle notch in the knob is visible above this crater