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Rolling of glaciovolcanic glass at the fluid threshold on Mars using wind tunnel simulation with an Icelandic analogue material

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Recent discoveries of volcanic glass on Mars show that amorphous materials are a vital ingredient in surface sediments and various aeolian landforms. Mobilisation of these materials still occurs today based on geomorphologic evidence of erosion patterns and dune migration. We suggest that particle mobility (rolling) below the saltation fluid threshold potentially affects the dynamic threshold at which sustained saltation is possible on Mars. Measuring a realistic fluid threshold for rolling of fresh glassy sediment was therefore the main aim of our study. In order to determine this threshold, we simulated the removal of a terrestrial analogue material in a low-pressure wind tunnel experiment.

Volcanic glasses on Mars are most likely originated from subglacial eruptions or other forms of glaciovolcanism and therefore share similar properties with volcanic glasses as for instance formed in Iceland. The compositional and morphological properties of the Martian glass particles are difficult to measure from orbit and hence we selected a fresh and unaltered material from Iceland based on analogues in formation conditions. Wind tunnel simulations at various atmospheric pressures inside the Aarhus Wind Tunnel Simulator (AWTS-1) were used to determine the shear stress required for removal by rolling. A semi-empirical model was fit to the data and used to predict removal on Mars. Various material properties of the glass were measured in order to evaluate the goodness of the obtained fit as a function the variation in material properties per particle size fraction. We found that the model can be validly applied to the analogue material and can therefore be used to predict the removal on Mars. Especially larger angular particles can be mobilised at the fluid threshold by rolling at shear stresses that were measured during strong winds and gust in the present-day environment of Mars.