Geophysical Research Abstracts
Vol. 20, EGU2018-7802-1, 2018
EGU General Assembly 2018

Jumping grains on Mars, or sediment transport by boiling: experiments and models

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In our previous laboratory work we reported a new sediment transport mechanism relevant for Mars: sediment saltation through boiling. We found seeping water was able to transport sediment downslope under martian conditions even though no sediment transport was observed under terrestrial conditions. This finding has important implications for inferring water reservoirs of recently active surface processes and hence for Mars' hydrosphere and habitability. However, in order to robustly transfer this finding to Mars we need to understand the physics behind this process. We can use this knowledge to define the limits of the process in terms of surface properties and/or environmental conditions found on Mars. In our previous work we inferred the physical mechanisms behind the saltation, yet we had little empirical data to test this inference. In this series of experiments we focused on the grain-scale processes involved in saltation via boiling with the objective of validating our physical model.

Our experiments were performed in the large Mars chamber at the Open University. Our set-up consists of two parallel confining walls 40 mm apart and 3.2 mm high adhered to an inclined roughened plane 0.4 m wide by 0.9 m long. Sediment was placed between the walls and levelled off. The water source was located at the top of the slope between the walls. We varied both initial slope angle (5°, 15°, 25°) and grainsize (120, 250 and 500 μm). Each experiment was performed at least in triplicate. Once the water is released, it percolates downslope through the sediment between the walls and the grains are observed to saltate at the saturated-dry interface. We used a high-speed camera in order to capture videos of the grain scale processes. We analyse these data with an open source particle tracking code called tractrac developed by Joris Heyman (https://perso.univ-rennes1.fr/joris.heyman/trac.html). We extract particle trajectories and from those an estimate of the initial ejection velocity for tens to hundreds of particles for the videos we collected. We then compare our experimental trajectories and ejections speeds with those predicted by our physical model. In this contribution we will report on this comparison.