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Boiling Water could Levitate Sediment on Mars – An Experimental Study

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We present laboratory studies of a newly recognized transport mechanism: “levitation” of sediment on a cushion of vapor released by boiling [1,2]. This mechanism can occur only under low atmospheric pressure with relatively ‘warm’ (for Mars) surface temperatures and can trigger dry avalanches.
Laboratory studies were conducted with a 90 $\times$ 40 $\times$ 50 cm sediment bed ($\sim$63-200 μm grain diameter) inclined at 25° within a Mars environmental chamber. Pressure was maintained at $\sim$9 mbar. For each experiment, pure water was introduced at the top of the slope, 1.5 cm above the sediment bed, and the flow behavior observed. The water was pumped into the chamber from an external reservoir allowing to control the water temperature and the flow rate at $\sim$11 ml s^{-1}. Each run consisted of 60 s of water flow and was performed in triplicate; digital elevation models (DEMs) of the bed were created both before and after each run using multiview digital photogrammetry [1,2].
Our experiments show that the amount of transported sediment is 9 times greater when the effect of levitation is taken into account. This was caused by a surface temperature difference of only $\sim$19 K under martian pressures. The temperature of the water is negligible and will not have much influence on the amount of transported sediment. Although the availability of liquid water at the surface of Mars is hard to explain, our experiments show that the amount of water needed for sediment transport could have previously been overestimated when surface temperatures are high ($\sim$300 K) and that less water may be required to transport sediment than previously thought [1]. Furthermore, the exact temperature of the martian surface in the recent past is not precisely known due to large obliquity changes [3]. A slight increase in the maximum surface temperatures in the past on Mars would increase the scope for boiling and sediment levitation and hence the transport capacity of water-driven flows.
The combination of levitation and dry avalanches increases the amount of sediment transport per volume of liquid water, so should be considered when evaluating the formation of recent and present-day martian mass wasting features such as gullies [e.g., 3,4,5] and recurring slope lineae (RSL) [e.g., 6,7,8,9]. This is not an explanation for the formation/activity of gullies and RSL, but is a process-observation.

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