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How does temperature affect aeolian abrasion on Mars?

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Oxidants can be generated through reactions involving freshly fractured silicate minerals, where reactivity is primarily determined by mineralogy and surface area (e.g., Edgar et al, 2022). Aeolian abrasion through saltation is the dominant form of landscape modification on Mars today (e.g., Bridges et al, 2004), a process that fractures silicate minerals, increasing reactive surface area. Importantly, the mechanical properties of minerals are known to vary with temperature, perhaps indicating that abrasion rates are temperature dependant and suggesting a previously unexplored temperature control on the reactivity of the Martian regolith.

Here, results are reported of laboratory experiments where a suite of single-phase, Mars-relevant minerals (olivine, pyroxene, feldspar, quartz and opal) were exposed to conditions simulating aeolian abrasion. Experiments were conducted at velocities slightly above Martian threshold wind speeds and at a range of temperatures encompassing the seasonal and diurnal variations measured at the Martian surface (193 to 293 K). Our 75-day experiment was equivalent to ~ 3 (Earth) years of continuous sand mobilisation on Mars. The proportion of material abraded below the starting grain size was recorded revealing each of the minerals tested produced significantly ($p < .05$) less fines at 193 K than at 293 K, with a mean decrease in fine production of ~ 22 %.

Further experiments were conducted where mineral pairs were abraded together. X-ray diffraction and X-ray fluorescence of the starting material and the fine fractions of the mineral pair experiments allow a comparison of geochemical trends to be made between our experiments and the Martian regolith. Geochemical trends in Martian dust compositions (relative to parent bedrock) were more closely replicated with abrasion experiments conducted at the lowest temperatures (193 K), suggesting the temperature of abrasion also exerts a control on the composition of Martian dust.

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