EGU General Assembly 2023

EGU23-8692, updated on 27 Apr 2024
https://doi.org/10.5194/egusphere-egu23-8692
EGU General Assembly 2023

How does sediment cycling work on Mars? Three investigations into the cycling of Martian aeolian sand

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Aeolian sand transport on Mars is active today and was likely so throughout its history. Widespread dune motion is theorized to comminute sand to sub-sand sizes, a process also implied by lab experiments. In view of this sand destruction, discovering the source(s) and origin(s) of Martian sand provides critical information for understanding Martian sediment cycling.

Local sand sources have been discovered and considered to be consistent with the long-standing hypothesis for Martian sand as volcaniclastic in origin. A local source of Martian sand has recently been inferred in the western Medusae Fossae Formation (wMFF). Given the pyroclastic origin of the vast MFF, the new discovery of sand generation from that deposit substantiates a volcaniclastic origin of Martian sand.

However, the wMFF is limited in extent and unlikely to constitute an origin for the globally distributed dune fields on Mars. Continued exploration for sand origins is needed to explain this widespread distribution.

We examined the five global geological units interpreted as volcaniclastic, which yielded limited evidence of sand sourcing outside the wMFF. In these five units, sand sourcing was detected in visible-wavelength data in the Hesperian and Amazonian transitional units that comprise the central and eastern MFF and in the Noachian units of Arabia Terra. Investigation to characterize sand production from these units is revealing a variety of sand source outcrops.

Tracing sand deposits back to their sources is another approach for determining sand origins, as was used in determining the source – and thereby the origin – of sand in and from the wMFF. Determining sources for the widespread sand on Mars requires determining sand survivability: how far could sand travel from their sources before being destroyed by comminution to sub sand sizes? Simulation of aeolian transport on Mars has shown different sand mineralogies comminuting at different rates, suggesting that the bulk mineralogy of a sediment may change with increased transport distance. Building on that previous experimental work, we are undertaking comminution of 14 different Mars-analog sands to more fully characterize the mineralogical and physical effects on sand of aeolian transport. The results will support using dune sand compositions and distances from possible source outcrops to test if these outcrops sourced the sand.

Thermal inertia is used to characterize Martian sand, e.g., to estimate grain sizes. Available dune field mapping facilitates investigation into dune sand thermal inertia values, thereby providing data, e.g., on sand particle sizes and induration states. As available mapping incorporates non-sand substrate, we are remapping dune fields to include only visible sand and using the distributions of thermal inertia values to assess if non-sand substrate is still included in our mapping. Having completed remapping of tropical dune fields, we are beginning analysis of their thermal inertia values. The results will reveal any trends relative to geography, underlying geologic unit, elevation, and other factors.

These three investigations – into the sources and origins, effects of transport, and thermal inertia values of Martian sand – will support improved understanding of Martian aeolian sand cycling, one of the most active geologic agents on Mars.