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CONSTRAINING THE GEOLOGIC HISTORY AND MODERN GEOMORPHOLOGY OF MARS USING HIGH RESOLUTION AND MULTISPECTRAL CAMERAS ON A SWARM OF WIND-DRIVEN MOBILE IMPACTORS

Abstract

To date, in-situ Mars exploration has provided planetary scientists with a unique opportunity to understand the planet and the history of the solar system, as 45% of the Martian surface is comprised of geologic units dated more than 3.7 billion years old. However, fundamental mechanisms of surface geological and geomorphological features on Mars cannot be determined by current missions, as they are limited by small surface coverage. As a result, there is a limited understanding of the presence of turbidite deposits along the Martian dichotomy, which would provide direct evidence of ancient deep-water environments. Additionally, the mechanisms of equatorial Recurring Slope Lineae (RSL) are debated along with glacier-like forms (GLFs) present in the polar regions of Mars. Studying them in-situ would enable further comprehension of the extent of surface liquid water, paleoclimates on Mars, and the possibility of future habitation on Mars.

The need for large-scale spatiotemporal datasets is addressed by a novel mission architecture that uses a swarm of wind-driven mobile impactors - the Tumbleweed Rovers. The Tumbleweed Science Mission is able to provide full coverage and high-resolution imaging at rugged and previously inaccessible locations on Mars. The objective of this paper is to investigate the utility of a multispectral camera integrated into a swarm of Tumbleweed Rovers, in order to answer long-standing questions regarding the geologic history and modern geomorphology on Mars.

We conduct a definitive feasibility study of a multispectral camera on a swarm of Tumbleweed Rovers, defining design requirements to attain baseline science goals. The proposed multispectral camera with 12 filters in the VNIR range is capable of distinguishing between the major mineral groups relevant to Mars, e.g. olivine, iron-oxides, and hydrated minerals. We also propose a hand-lens style imager, capable

of determining the distribution of grain sizes present in common sedimentary formations (sandstones, siltstones, and mudstones). With this instrumentation, we show that the Tumbleweed Science Mission enables searching for turbidites, constraining the composition and mechanics of RSL, and mapping the extent of glacier-like forms in the high latitudes.

Using a systems engineering-based approach, we demonstrate that Tumbleweed Rovers can significantly improve our understanding of the geology and modern geomorphology of Mars by providing high-resolution images at rugged, high-latitude locations.