Investigating the Transition from Sand Ripples to Megaripples on Earth and Mars

Abstract 1186

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Introduction: Can transitional bedforms be identified within the size range between that of 'normal' sand ripples and megaripples? This is the question to be addressed by a project recently funded by the Smithsonian Scholarly Studies Awards program. Here we present the rationale for the project, plus preliminary results used to justify our proposed methods of research. The project will be completed during FY19.

Ripples and Megaripples on Earth: For years we have been studying megaripples (bedforms 1 to 3 m in wavelength and 10 to 25 cm in height) at Great Sand Dunes National Park (GSDNP) in central Colorado [1], where 'granules' (particles 1-3 mm in diameter; see [2]) derived from nearby Medano Creek coat the surface of megaripples (Fig. 1) that are common along the southern margin of the main dune complex. Regular sand ripples (roughly 10 cm wavelength) encroach upon the megaripples that are only mobile during strong wind events [3]. The two classes of depositional bedforms typically are separate, but occasionally there appears to be a possible connection between sand ripples and adjacent granule ripples (center left, Fig. 1). Granules are moved by creep induced from the impact of saltating sand grains, and in places they accumulate on the upwind side of sand ripples (Fig. 2). We will make sections through transitions between sand ripples and megaripples in three dimensions, looking for any evidence of what contributes to the growth of the megaripples. We will also collect high-resolution digital photos of transition areas in order to use structure-from-motion software to generate detailed digital terrain models (DTMs); a proof of concept example is shown in Figs. 3 and 4, along with topography obtainable from such DTMs (Figs. 5 and 6). We will carry out two field trips at GSDNP in 2019 to collect macro photos and create 3D models for detailed characterization of the particles across transition zones.

Figure 1. Sand ripples (top; 10 cm wavelength) and larger granule ripples at GSDNP. The granules have a higher albedo than the sand, making the granule megaripples distinctly brighter than the sand. Possible interaction between sand ripples and megaripples to the lower left of center. JRZ, 4/11/18.

Figure 2. Granules superposed on sand ripples at GSDNP. Ruler labeled divisions are in cm. JRZ, 9/19/18.

Ripples and Megaripples on Mars: Information gained from GSDNP will augment a concurrent examination of possible sand ripple to megaripple transitions on Mars. We have selected the floor of Nirgal Vallis (27°-30° S, 313°-322° E) as the place to look for possible transitions. HiRISE images allow us to map both in excellent morphologic detail (Fig. 7), including multiple scales of aeolian bedforms [4], along with surface slope information from a DTM to be produced from the only HiRISE stereo pair of Nirgal Vallis. Nirgal Vallis features will be compared to bedforms in Gamboa Crater [5], where continuous crests can be followed from sand ripples on the tops of small sand dunes to megaripples surrounding the dunes (Fig. 8). Bedform crests will be mapped semi-automatically using an Artificial Nerual Network algorithm previously applied to mapping linear aeolian features in HiRISE images [6].

Relationship to Broader Goals: If sand ripples show no relationship to adjacent megaripples, then these features represent two distinct feature groups. If sand ripples do transition directly into megaripples, they are potentially related and determining an explanation for the change becomes important. Either way, this study will shed light on the situation in a way that is distinct from existing publications related to particle mobility on Earth and Mars. Assessing a relationship between ripples and megaripples may also be helpful to future Mars rover mission planners because the Opportunity rover became stuck for several weeks in a Martian megaipple [7], so improved understanding of these features is important for both scientific and operational reasons.

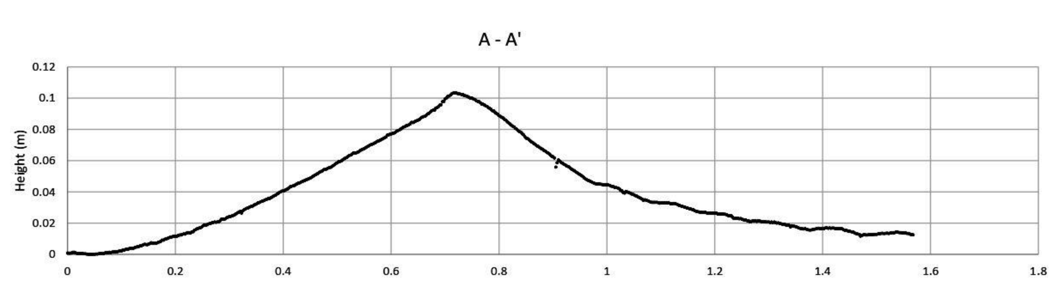

Figure 5. Topography of a megaripple from DTM shown in Fig. 4.

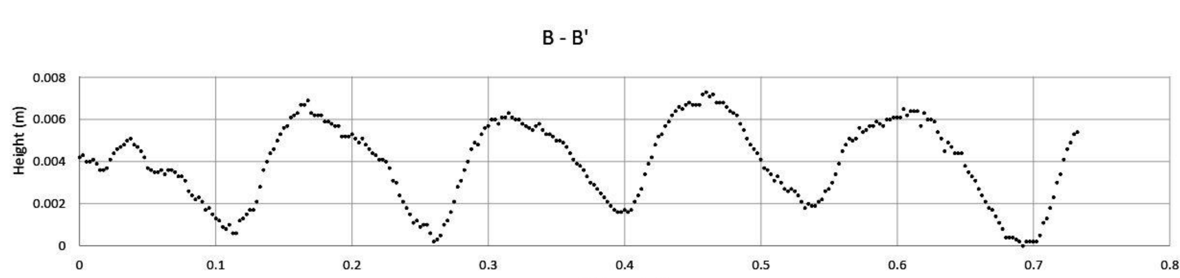

Figure 6. Topography of sand ripples from DTM shown in Fig. 4.

References: [1] Madole R. F. et al. (2008) *Geomorph., 99*, 99-119. [2] Sharp, R. P. (1963*) J. Geol., 71,* 617-636. [3] Zimbelman J. R. et al. (2009) *Icarus 203,* 71-76. [4] Bridges N. T. et al. (2007) *GRL, 34*, L23205. [5] Zimbelman J. R. (2010) *Geomorph., 121*, 22-29. [6] Foroutan M. and Zimbelman J. R. (2017) *Geomorph., 293*, 156-166. [7] Squyres S. W. et al. (2006*) JGR Planets, 111*, E12S12. [8] Zimbelman, J. R. (submitted) *Icarus*.

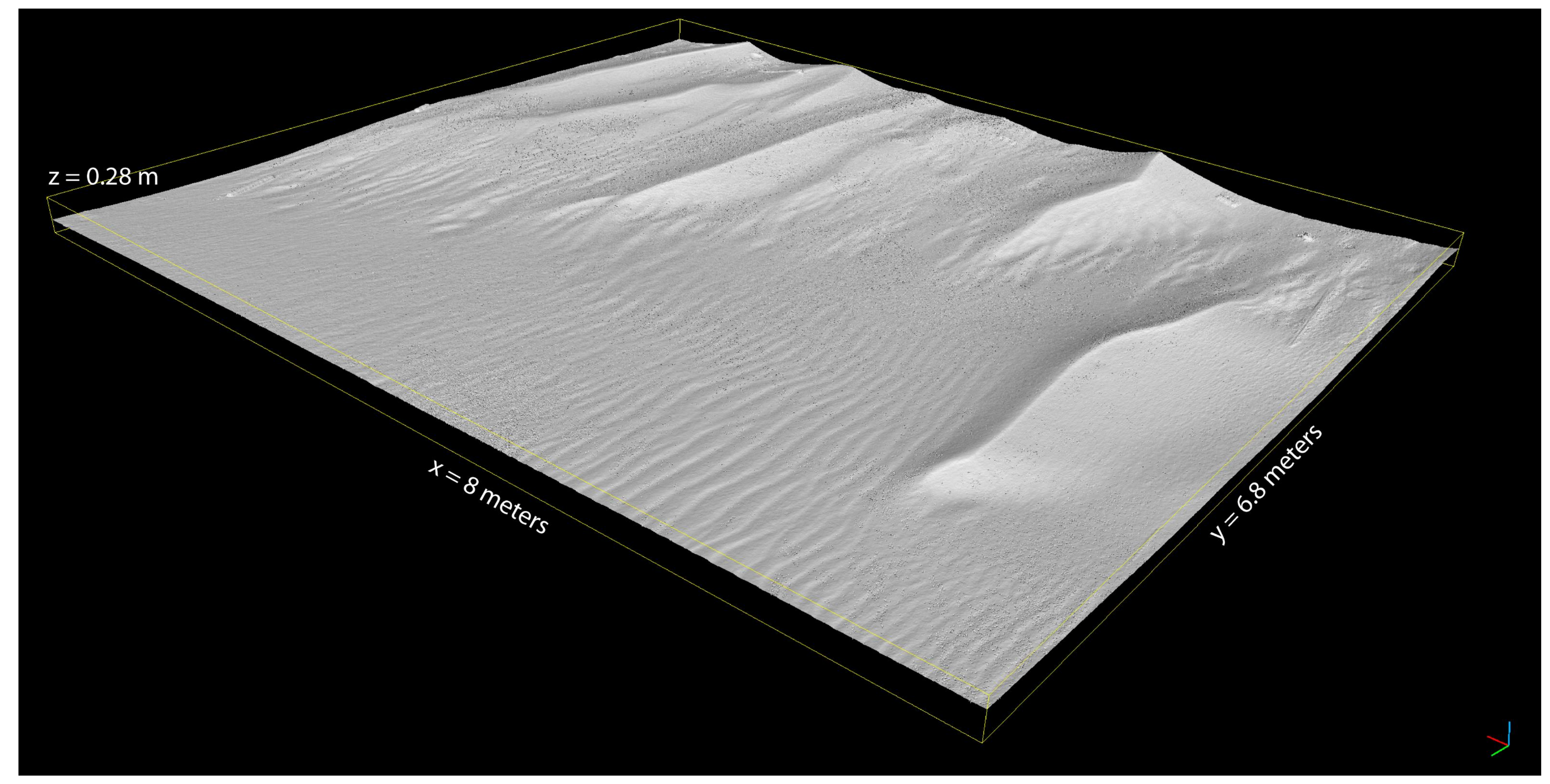

Figure 3. Shaded relief perspective view of DTM derived from shape-from-motion software applied to photos taken at GSDNP on 9/19/18.

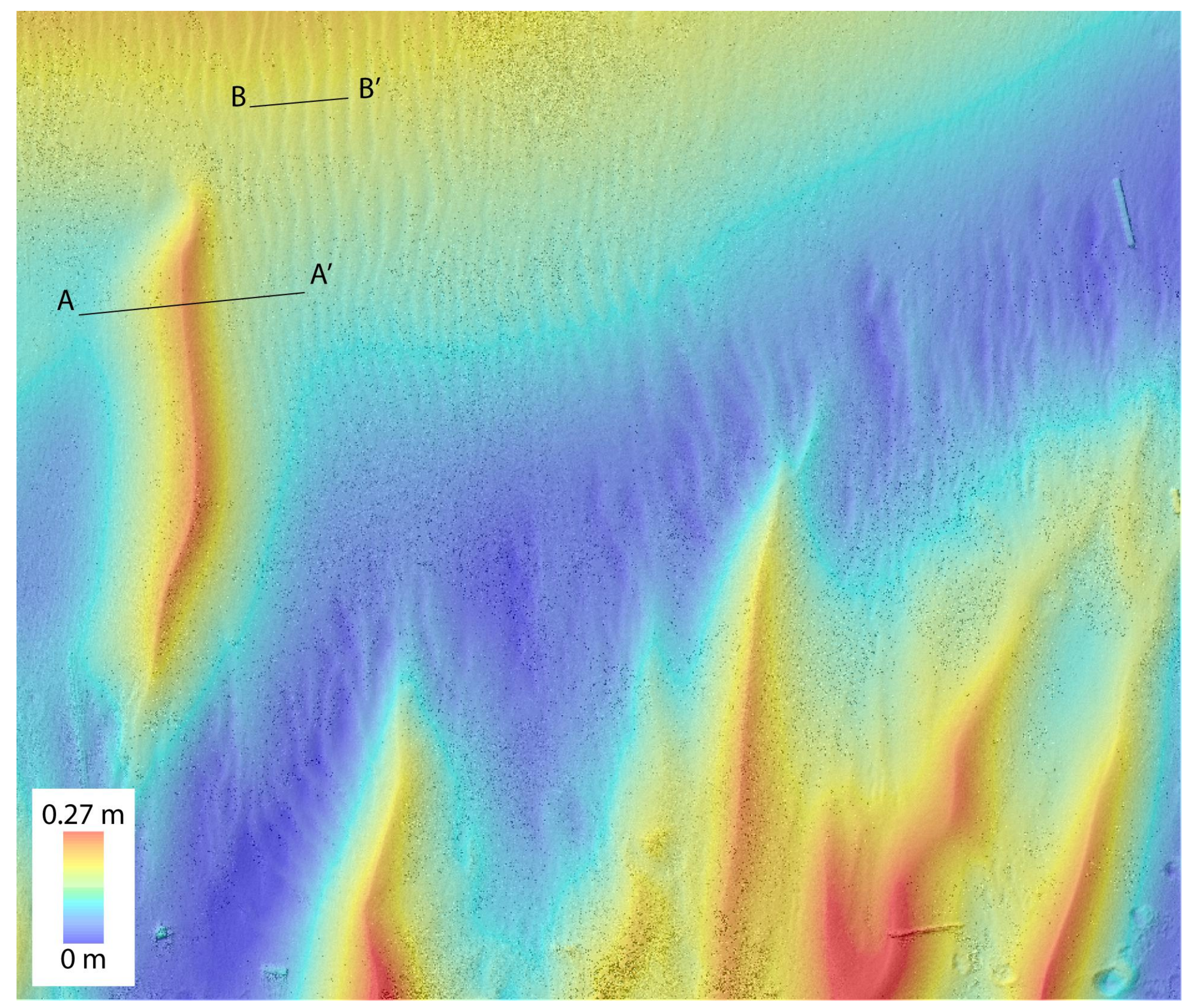

Figure 4. Colorized vertical view of DTM derived from shape-from-motion software. Point of view for Fig. 3 is from upper left in this view. Locations of profiles shown in Figs. 5 and 6 are labeled.

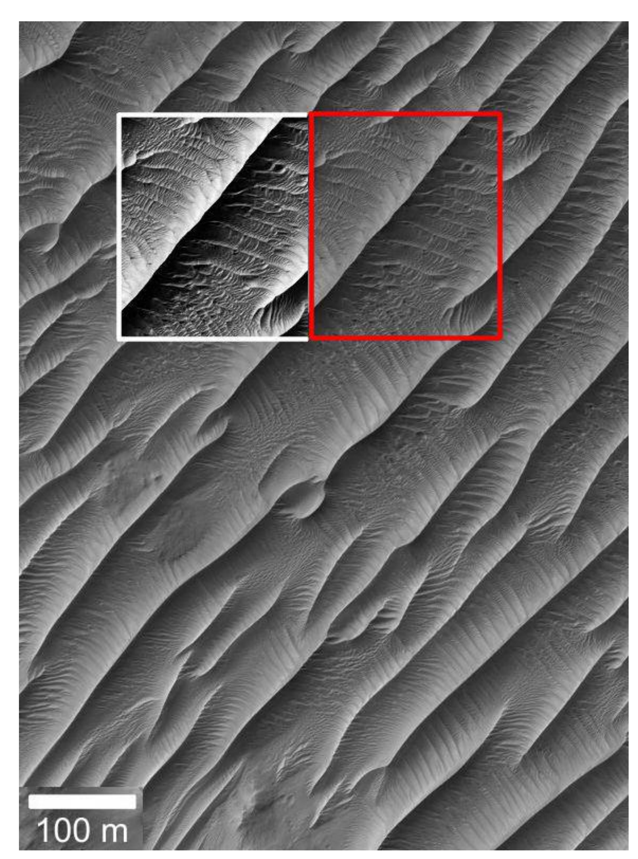

Figure 7. Ripples and meagripples in Nirgal Vallis, Mars. White box is a histogram equalization stretch of area in red box. Portion of HiRISE frame ESP_034605_1515, NASA/JPL/U of A.

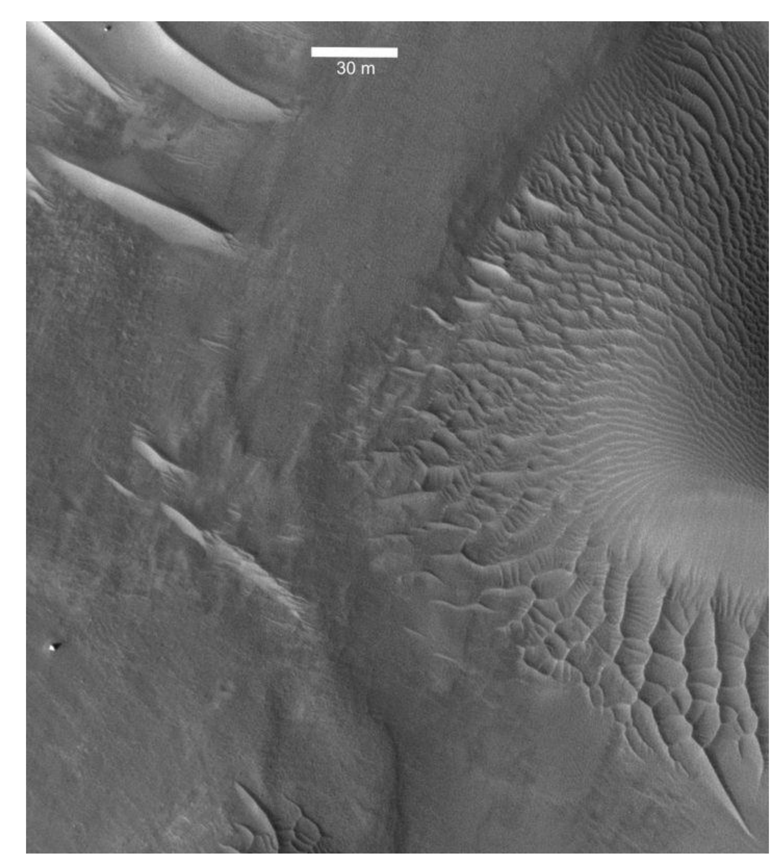

Figure 8. Aeolian bedforms on the floor of Gamboa crater, Mars. Sand ripples on the small sand dune at right can be traced to crests of megaripples around the base of the dune [8]. Portion of HiRISE frame ESP_034605_1515, NASA/JPL/U of A.