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First evidence for bright-toned megaripple migration on Mars

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Abstract

Here we show the first evidence for bright-toned bedform migration on Mars. These features are migrating on a temporal baseline of 8-10 terrestrial years.

1. Introduction

The action of the wind accumulated on the surface of Mars vast fields of aeolian bedforms [1-4]. The study of these features is fundamental to constrain present and past climatic conditions. Along with the dunes, two other types of aeolian bedforms have been identified from orbital images [5]: 1) dark toned ripples (DTRs), 1-5 m spaced and ~40 cm high which overprint the dune's slopes [6] or form vast isolated fields [7-9], and 2) Transverse Aeolian Ridges (TARs), which are bright-toned features 10-100 m spaced and ~1-14 m tall [10]. Active DTRs found on dune slopes have been interpreted as normal ripples [7, 11] or fluid-drag ripples [12], whereas inactive DTRs not associated with dunes have been suggested to be megaripples [8, 9]. TARs are static features that have been interpreted as megaripples or small dunes [10, 13]. Prior investigation concluded TARs are inactive under current climatic conditions [14, 15]. In this report we investigate the nature and activity of 8-18 meter-spaced bright-toned bedforms which have sizes in between DTRs and TARs (Fig. 1). We investigated the activity of bright-toned bedforms on overlapping orthorectified HiRISE images [15-17].

2. Results

We have identified larger bright-toned bedforms in several areas of Mars including Nili Fossae and McLaughlin crater (Fig. 1). McLaughlin crater is located ~200 km NE from the ExoMars 2020 proposed landing site in Oxia Planum. The bright-toned bedforms are preferentially located behind or in between dunes suggesting a megaripple origin. They can be in continuity with nearby DTRs (Fig. 1a, b) or stratigraphically below nearby dunes and DTRs (Fig. 1c). The megaripples normally have a rectilinear shape and orientation similar to nearby DTRs (Fig. 1a, b). However, more complex star-like shapes are also observed. The bright-toned megaripples show unambiguous modifications on a temporal baseline of ~8-10 Earth years. Like the active DTRs found on the dune slope [18, 19], the megaripples can migrate obliquely and seem to be associated with high sand flux dunes [20]. Barchan-shaped dunes in Nili Fossae are associated with 2-to-20-meter spaced (5.5 m on average) bright-toned megaripples. The dunes have two different slip faces but the bright-toned bedforms lagging behind are only moving toward the NW. The migration rates of the megaripples is controlled by the local topography and the associated flux can be two orders of magnitude lower than dune crest fluxes. In addition, megaripple fluxes have a narrower directional distribution compared to dune fluxes.

3. Summary and Conclusion

In this report we presented the first evidence of bright-toned megaripple migration on Mars. These features have wavelengths in between DTRs and small TARs and are migrating in the present-day climate. The presence of these migrating megaripples together with inactive bedforms suggest a complex aeolian scenario characterized by strong winds and bedform induration. Most of the detected active megaripples form a continuum with active DTRs found on dune slopes suggesting common formative processes. Their migration rates and direction can be used to track strong Martian winds and will provide further ground truth for atmospheric models.

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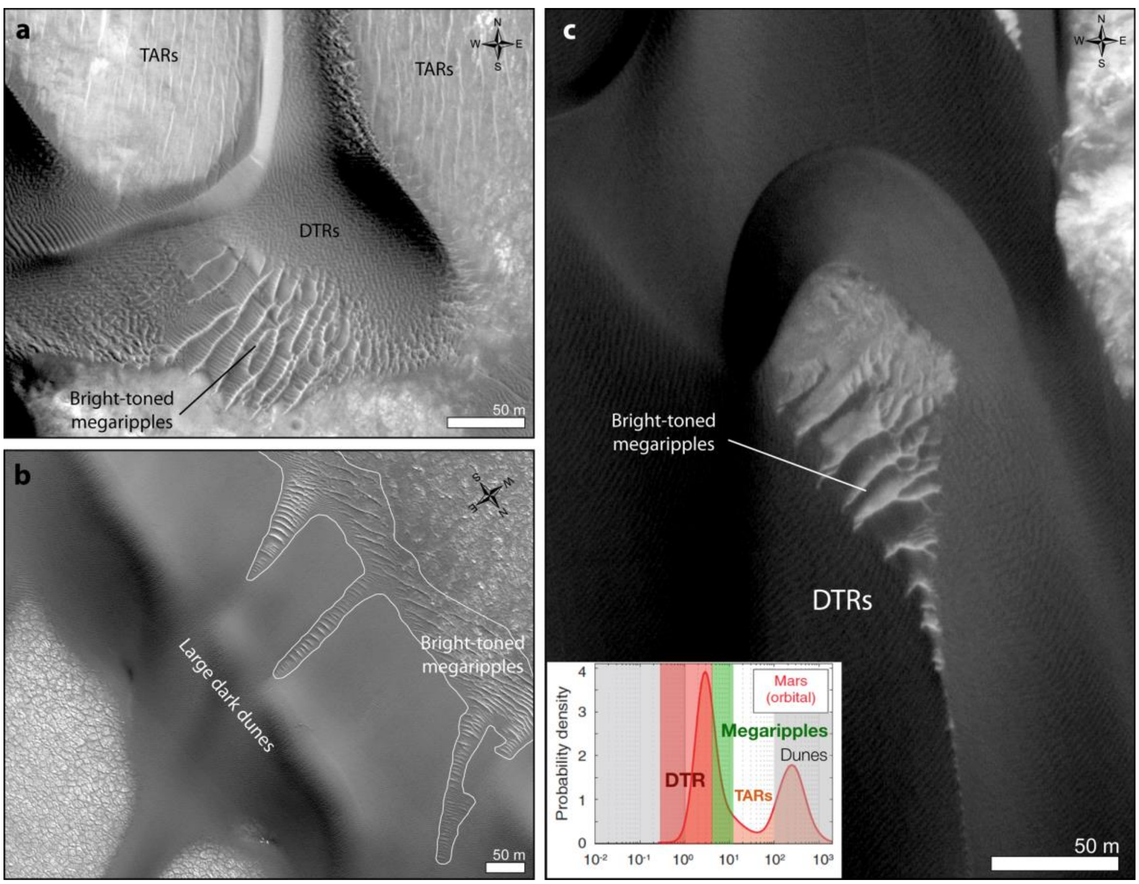

Fig. 1: Active bright-toned megaripples on Mars imaged by the HiRISE camera in a) Nili Fossae (ESP_047049_2015), b) North Pole (ESP_027369_2580) and c) McLaughlin crater (ESP_045312_2020). The megaripples have wavelength in between Dark Toned Ripples (DTRs) and Transverse Aeolian Ridges (TARs). (Inset) Histogram of orbital-detected bedforms (modified from [12]).