TRANSVERSE AEOLIAN RIDGES ON MARS: RESULTS OBTAINED FROM ANALYSIS OF HiRISE IMAGES.
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Introduction: Sand-sized particles have played a significant role in the geologic history of Mars, particularly with regard to the numerous sand-related landforms that are prevalent across the planet at a variety of scales [e.g., 1-4]. Recent data support an evaluation of the role played by graunules and impact creep in the formation of aeolian transverse landforms with wavelengths <100 m [5-7], features given the general name 'Transverse Aeolian Ridges' (TARs) to allow for both dune and ripple processes during their formation [8, 9]. Mars Orbiter Camera (MOC) Narrow Angle (NA) images first clearly revealed the wide distribution of transverse bedforms with wavelengths of ~20 to 80 m [2]; a survey of MOC NA images from pole to pole in the longitudinal band of 180° to 240° E showed that TARs were pervasive equatorward of 60° latitude in both hemispheres [9], but MOC data remained inconclusive as to whether the smallest TARs (wavelengths <50 m) were large ripples or small dunes [5]. New images obtained by the High Resolution Imaging Science Experiment (HiRISE) [10] provide important information about aeolian features on Mars [11, 12]. Here inferences about TARs obtained from portions of HiRISE images are compared to field measurements for dunes and ripples from the western US [13].

Ius Chasma: The first full-resolution HiRISE image released to the public (TRA_000823_1720) revealed an abundance of TARs at wavelength scales ranging from ~5 m to >80 m, imaged at 25 cm/pixel resolution. This HiRISE image shows not only complex interactions of the crests of TARs, but also crenulation of TAR crests, along with the presence of a distinct class of smaller landforms (wavelengths <20 m) in the troughs between, and superposed on, the large TARs (Fig. 1). The smaller features are oriented perpendicular to the crests of the large TARs, suggesting that they are the result of wind flow along the large TARs; this observation is consistent with HiRISE observations from across the planet that reveal two or even three orders of aeolian bedforms, each apparently influenced by their larger neighbors [12]. The spatial resolution of the HiRISE image provides the first clue to the shape of TAR bedforms through simplified photoclinometry (Fig. 2) [6]; the symmetric shape is more consistent with the shape of granule coated ripples than with the profiles of either sand ripples or linear sand dunes, with the exception of reversing dunes (which have shapes very similar to that of Fig. 2) [7].

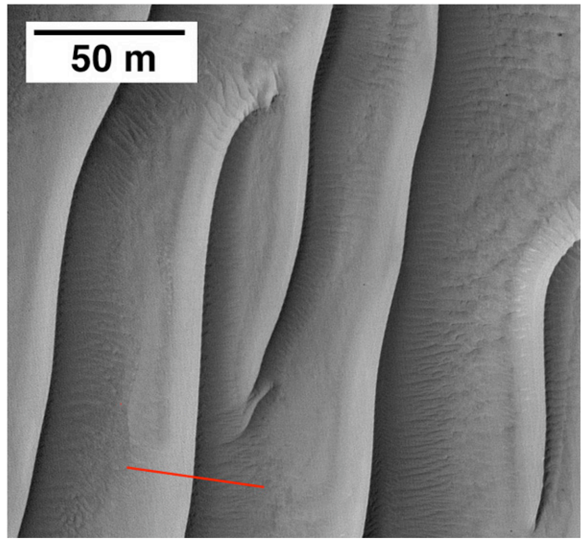

Figure 1. TARs on the floor of Ius Chasma. From HiRISE image TRA_000823_1720, 7.8°S, 279.5°E. Line shows location of profile in Figure 2.

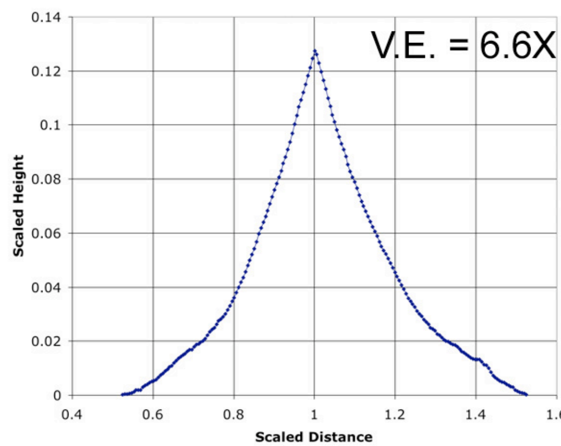

Figure 2. Profile of TAR shown in Fig. 1. Both height and width are scaled to the 45 m width of the feature.

Gamboa Crater: HiRISE image PSP_002721_2210, of the interior of Gamboa impact crater, reveals information about the interaction between what are obviously sand accumulations and a 'reticulate' [12] arrangement of smaller bedforms surrounding the sand patches (Fig. 3). The distribution of various types of aeolian bedforms were mapped across the floor of Gamboa crater, identifying classes of both broad, low-albedo features lacking slip faces and narrow, relatively linear, medium-to-high albedo features more typical of TARs seen in MOC NA images [14]. Photo-

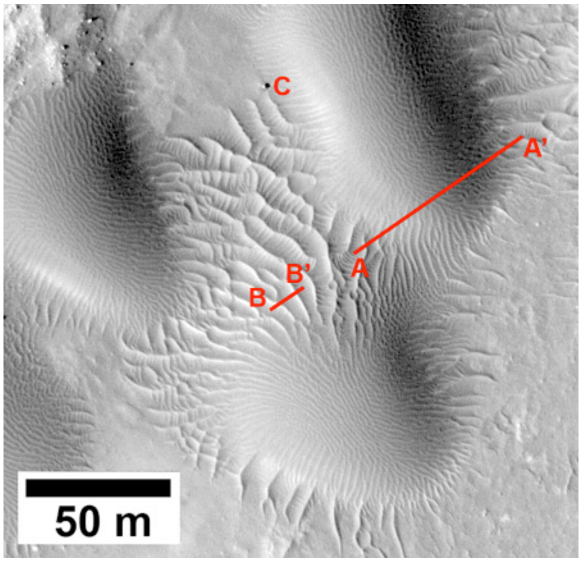

Figure 3. Dunes and ripples on the floor of Gamboa crater. A-A' and B-B' are locations of profiles shown in Fig. 4. Shadow length indicates that the block at C is 0.8 m tall. From HiRISE image PSP_002721_2210, 40.8°N, 315.7° E.

clinometry provides valuable information about the profile shapes of both the dark dune patches and the bright TARs (Fig. 4); the dark sand patches (Fig. 4, top) are comparable to incipient dunes that have not yet collected sufficient sand to develop a slip face, while the smaller ridged features (Fig. 4, bottom) are identical to granule-coated sand-cored ripples [14].

Other HiRISE images: The TARs just described are distinct from duneforms in HiRISE images targeted on dune fields (e.g., Proctor, PSP_004077_1325; Rabe, PSP_003325_1355; Herschel, PSP_002728_1645; Nili Patera, PSP_004339_1890). TARs inside a crater in Terra Sirenum (PSP_001684_1410) show unusual crest truncations and branching, apparent layering in between the TAR bedforms, and extremely narrow terminations of some TARs, all of which suggest that these TARs perhaps are being eroded.

Conclusions: Broad, low-albedo features are most likely sand dunes, even where they lack slip face development. Medium to large TARs (generally wavelengths 40 to 100 m) are most likely reversing sand dunes. Small TARs (wavelengths <20 m) are most likely either granule-coated ripples or very small dunes (although such dunes would be substantially different from the dark sand patches and dunes with slip faces).

Acknowledgements: This work was supported by grant NNG04GN88G from the NASA Mars Data Analysis Program.

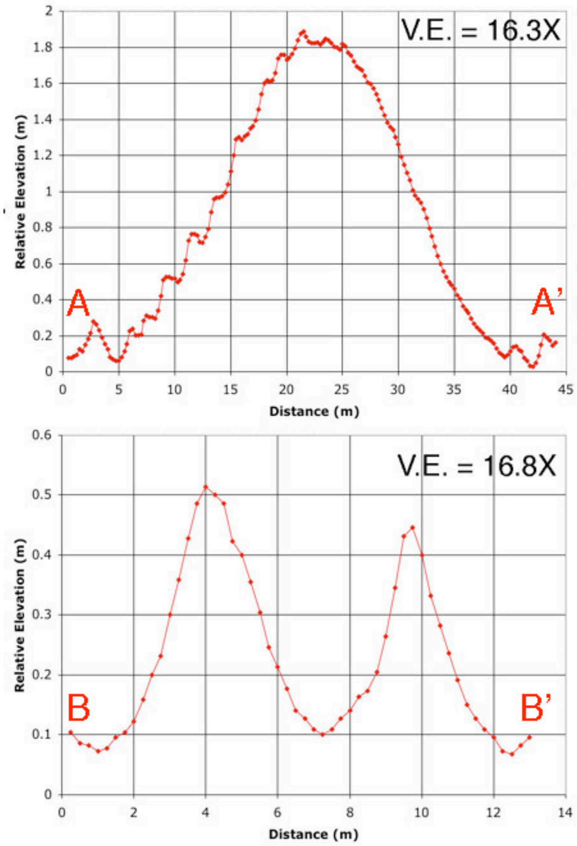

Figure 4. Relief for profile locations shown in Fig. 3; note differing scales. The top profile is comparable to incipient sand dunes (lacking a slip face) on Earth, and the bottom profiles are nearly identical to granule ripples in the western US [14].

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