INFERENCES ABOUT SAND DUNES ON MARS DERIVED FROM THE ANALYSIS OF TWO HiRISE IMAGES. J. R. Zimbelman[1] and S. H. Williams[2], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington, D.C. 20013-7012, USA; zimbelmanj@si.edu, [2]Education/NASM MRC 305, Smithsonian Institution, Washington, D.C. 20013-7012, USA; williamssh@si.edu.

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]. Our recent work has focused primarily on an evaluation of the role played by graunules and impact creep in the formation of aeolian transverse landforms at wavelength scales <100 m [5-7], features given the general name of 'Transverse Aeolian Ridges' (TARs) to allow for both dune and ripple processes to contribute to their formation [8, 9]. The resolution (down to 25 cm/pixel) available in new images obtained by the High Resolution Imaging Science Experiment (HiRISE) [10] on the Mars Reconnaissance Orbiter provides important new information about aeolian features on Mars [11]. Here we present some inferences about TARs obtained from an investigation of portions of two HiRISE images, compared to field measurements collected for dunes and ripples from locations across the western US [12].

Background: Most aeolian bedforms on Mars appear to be oriented transverse to the inferred wind direction [1, 2], indicating a paucity of longitudinal dunes, one of the most common dune types on Earth [13]. 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, which form by very different processes [5].

Ius Chasma: The very first full-resolution HiRISE image released to the public (TRA_000823_1720, released as NASA PIA08792) revealed an abundance of TARs at wavelength scales ranging from ~7 m to >80 m; since then these features have been imaged at 25 cm/pixel resolution. This HiRISE image shows not only complex interactions of the crests of TARs, including a 'star dune'-like crest pattern at some locations (e.g., upper right corner of Fig. 1), but also regular crenulations of some TAR crests along with the presence of a distinct class of smaller TAR landforms (wavelengths <20 m) in the troughs between, and superposed on the sides of, the large TARs (Fig. 1). These smaller features are oriented roughly perpendicular to the crests of the large TARs, suggesting that they are the result of wind flow around the large TARs; this observation from Ius Chasma is consistent with initial HiRISE observations from across the planet that reveal two or even three orders of aeolian bedforms, each apparently influenced by their larger neighbors [11]. The spatial resolution of the HiRISE image provides the first clue to the shape of TAR bedforms through simplified photoclinometry [6]; their symmetric shape is generally 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 (for which the shapes are very similar) [7].

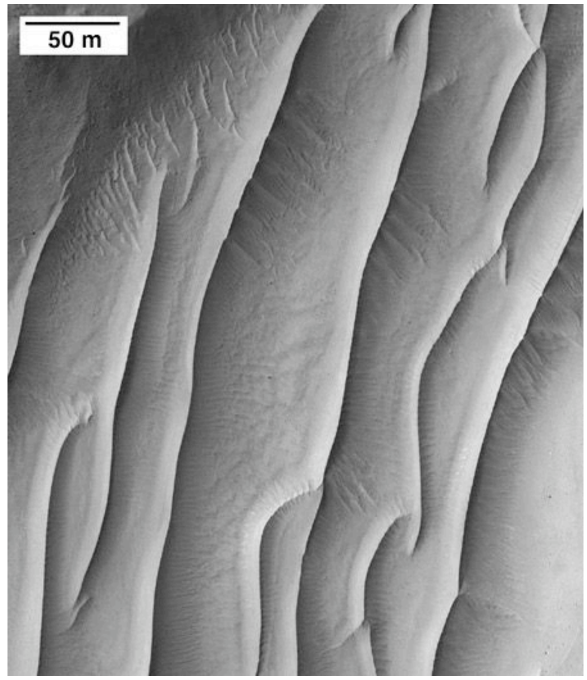

Figure 1. TARs on the floor of Ius Chasma. From HiRISE image TRA_000823_1720, 7.8°S, 279.5°E.

Gamboa Crater: Aeolian features appear in many, if not most, HiRISE images. An image of the interior of Gamboa impact crater, which was imaged repeatedly by MOC NA (most likely to monitor gullies in the crater rim), reveals intriguing information about the interaction between what are obviously sand accumulations and a 'reticulate' [11] arrangement of smaller bedforms surrounding the sand patches (Fig. 2). We mapped the distribution of various types of aeolian bedforms on the floor of Gamboa crater, identifying

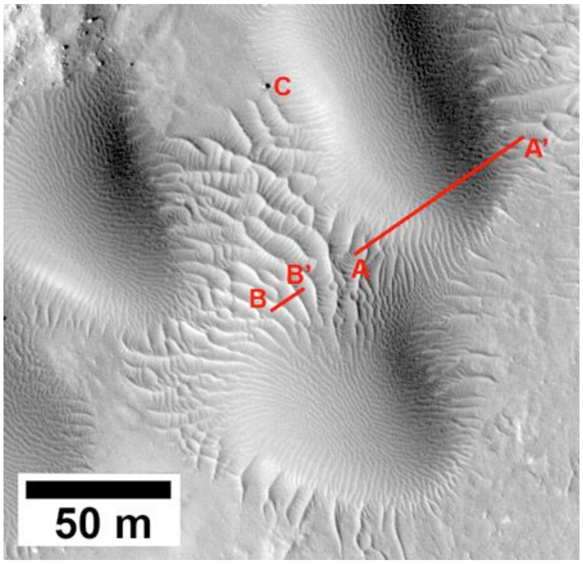

Figure 2. Dunes and ripples on the floor of Gamboa crater. A-A' and B-B' are locations of profiles shown in Fig. 3. Shadow length indicates that the block at C is 0.8 m tall. From HiRISE image PSP_002721_2210, 40.8°N, 315.7° E.

classes of both broad, low-albedo features lacking slip faces and narrow, relatively linear, medium-to-high albedo features more typical of the TARs that are common in MOC NA images [14]. Photoclinometry provides valuable information about the profile shapes of both the dark dune patches and the bright TARs (Fig. 3). Both profile shapes are very similar to aeolian features on Earth; the dark sand patches (Fig. 3, top) are comparable to incipient dunes that have not yet collected sufficient sand to have well-developed slip faces while the smaller TAR-like features (Fig. 3, bottom) are identical to granule-coated sand-cored ripples [14]. We look forward to being able to test these initial results with the growing bounty of HiRISE images obtained from across the planet.

Preliminary 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 granule-coated ripples (the smaller of the features) or very small dunes (although such dunes could be substantially different in origin than the dark sand patches).

Acknowledgements: This work was supported by grant NNG04GN88G from the Mars Data Analysis Program of NASA, and support for a portion of the field work from Smithsonian Institution Endowments.

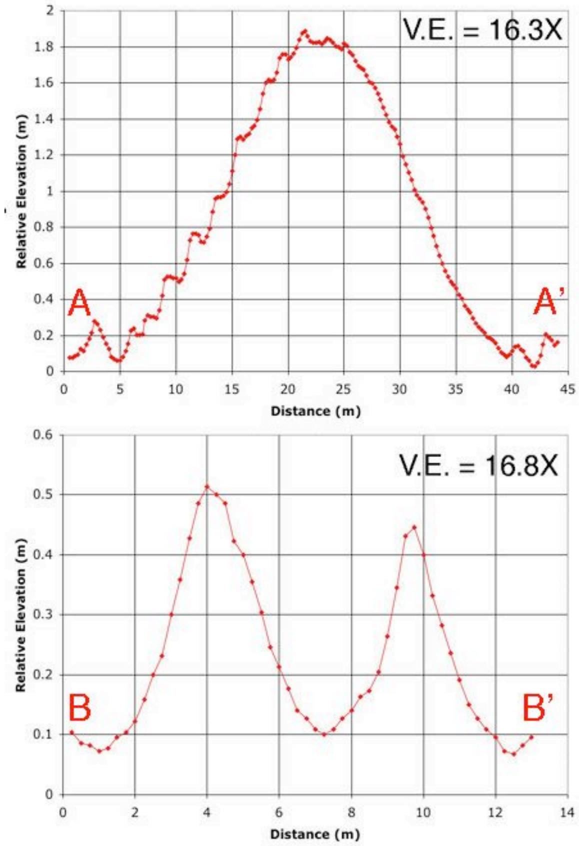

Figure 3. Relief for profile locations shown in Fig. 2; note differing scales. The top profile is comparable to incipient sand dunes (lacking a slip face) on Earth, and the bottom profiles are nearly identical to granule ripples in the western US [14].

References: [1] Greeley R. et al. (1992) *Mars*, U of A Pr., 730-766. [2] Malin M. C.and Edgett K. S. (2001) *JGR, 106*, 23429-23570. [3] Greeley R. et al. (2004) *Science, 305*, 810-821. [4] Sullivan R. et al. (2005) *Nature, 436*, doi: 10.1038/nature03641. [5] Zimbelman J. R. and Williams S. H. (2006) *LPS XXXVII*, Abstract #2047. [6] Zimbelman J. R. and Williams S. H. (2007) *7th Int. Mars Conf.*, Abstract #3047. [7] Zimbelman J. R. and Williams S. H. (2007) *GSA Abs. Prog., 39(6)*, Abstract 218-5. [8] Bourke M. C. et al. (2003) *LPS XXXIV*, Abstract #2090. [9] Wilson S. A. and Zimbelman J. R. (2004) *JGR, 109*, E10003, doi: 10.1029/2004JE002247. [10] McEwen A. S. et al. (2007) *JGR, 112*, E05S02, doi: 10.1029/JE002605. [11] Bridges N. T. et al. (2007) *LPSC XXXVIII*, Abstract #2098. [12] Zimbelman J. R. and Williams S. H. (2007) *Geology of Mars*, Cambr. Un. Pr., 232-264. [13] Breed C. S. et al. (1979) *USGS Prof. Paper 1052*, 305-397. [14] Telling J. W. et al. (2007) *Eos Trans. AGU, 88(52)*, Abstract P13A-1038.