

**TRANSVERSE AEOLIAN RIDGES ON MARS: DISTRIBUTION, ORIENTATIONS, AND AGES.** D.C. Berman<sup>1</sup>, M.R. Balme<sup>1</sup>, M.C. Bourke<sup>1</sup>, S. Rafkin<sup>3</sup>, and J.R. Zimelman<sup>2</sup>, <sup>1</sup>Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ, 85719, [bermandc@psi.edu](mailto:bermandc@psi.edu); <sup>2</sup>Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, PO Box 37012, MRC 315, Washington, DC 20013-7012; <sup>3</sup>Southwest Research Institute, 1050 Walnut St, Suite 300, Boulder, CO 80302.

**Introduction:** Mars is host to a wide range of aeolian forms such as dunes, ripples, dust devils, dust storms, yardangs, and ventifacts. Large dune fields characterized by low albedos and large duneform sizes have been observed and occur mainly around the north polar cap and in the southern mid-latitudes. However, another morphologically and dimensionally distinct population of aeolian bedforms has also been noted. These are generally brighter than the surrounding terrain, are about an order of magnitude smaller than the large, dark dunes (LDDs) and have simple forms. These bedforms have been designated ‘Transverse Aeolian Ridges’, or ‘TARs’ [1].

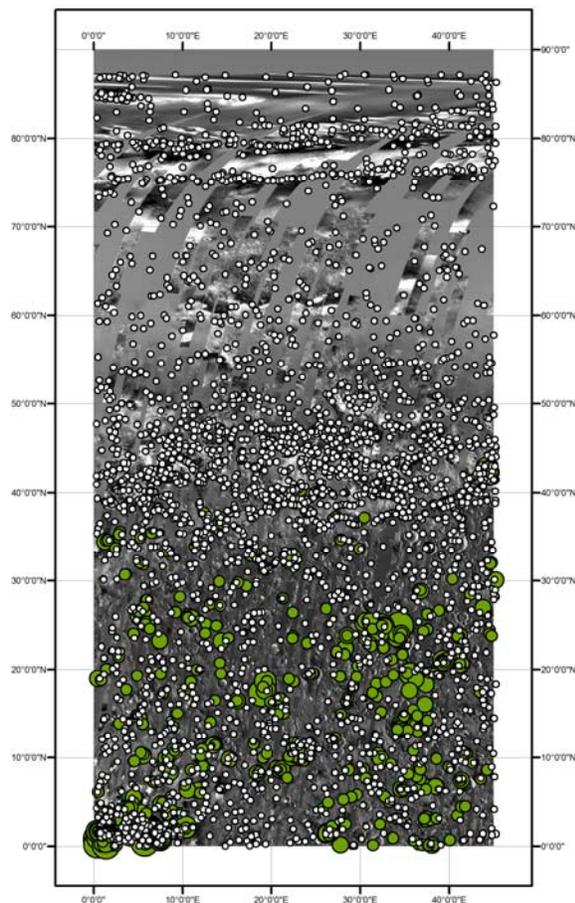


Figure 1. Percent areal coverage of TARs in MOC images for northern hemisphere. White dots represent MOC images with <5% TARs. Green dots show proportional percentages greater than 5%.

We have conducted a survey of all high-resolution (~1-11 m/pixel) Mars Orbiter Camera (MOC) images (~10,000 images) in a pole-to-pole swath between 0 and 45° E longitude to identify and classify TARs. This work extends the preliminary survey of [2], and was conducted on the opposite site of the planet. The aims are to determine TAR distributions, orientations, morphologies and morphometries, possible sediment sources, and superposition relationships with LDDs. Approximate percentage of areal coverage of TARs in each MOC image was recorded, as well as classification according to [3] and associations with other features such as LDDs and slope streaks.

**Distributions:** The geographic distribution of TARs is significantly non-random: in the northern hemisphere, TARs are most commonly found between 0 and 35° N, particularly in the Terra Meridiana region. 668 MOC images in the northern hemisphere contained at least 5% areal coverage of TARs (Fig. 1). In the southern hemisphere, TARs are found between 0 and 55° S. 1591 MOC images in the southern hemisphere had 5% or more areal coverage containing TARs (Fig. 2). TARs tend to be found on crater floors and in regions containing mesas and layered terrains; in short, anywhere where steep slopes, and therefore significant mass-wasting, can occur. The geographical distribution of different classes of TARs is also non-random: there are a much higher proportion of TARs classified as ‘barchan-like’ in the Meridiana region than anywhere else in the study region.

**Sediment sources for TARs:** The source of sediment for TARs is currently unknown. Although associations of slope streaks with TARs are common, it seems unlikely that enough sediment can be supplied to create all the TARs observed. Neither are there any obvious specific source regions, nor readily observable regional sediment pathways. Large numbers of TARs have been found in Terra Meridiana, a region containing large outcrops of layered material. This suggests that mass wasting and/or weathering combined with deflation of these layered outcrops is the local source for TAR sediments. Associations with LDDs suggest a common sediment source for the two landforms.

**Superposition relations with other geological features:** In many locations TARs have orientations

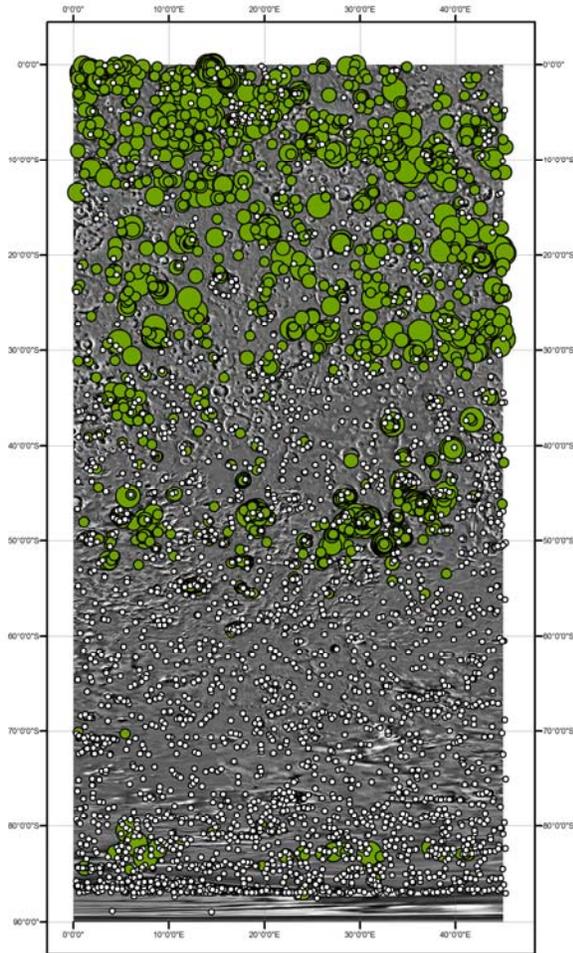


Figure 2. Percent areal coverage of TARs in MOC images for southern hemisphere.

consistent with other aeolian landforms such as LDDs. However, these landforms evolved over very different time scales. LDDs, being larger, are likely to have formed more slowly than TARs. This suggests that the regional winds have been consistent over long periods.

In equatorial regions and the northern hemisphere, TARs generally superposed by LDDs, or other dark aeolian materials, suggesting perhaps that TARs formed and then became immobile (perhaps becoming indurated?) before other aeolian features formed. This idea is reinforced by observations of impact craters in TARs [5]. In/near very large deposits of LDDs in the southern hemisphere, however, TARs often appear to superpose LDDs.

**Orientations and GCM comparisons:** Orientations of topographically independent TARs tend to be consistent over large areas (several degrees), indicating TARs are formed by large-scale wind patterns. TAR orientations match GCM wind orientations [6] fairly well (Fig. 3). GCMs were produced for multiple obliqu-

uities in order to determine relationships between TAR formation and climate change. TAR orientations in general seem more consistent with obliquities closest to the current Mars obliquity ( $\sim 22^\circ$ ), suggesting that TAR formation occurred in recent geologic time.

**Ages:** We have performed crater counts on several 25cm/pixel HiRISE images in equatorial TARs and southern intracrater TARs. Equatorial TARs contain impact craters and give crater retention ages of 1-3Ma. No craters  $> 5-10$  m in diameter were found on the southern intracrater TARs, giving crater retention ages of  $< 100$ ka, in agreement with superposition relations.

**Conclusions:** Transverse Aeolian Ridges (TARs) are widespread on Mars and are found at low to mid-latitudes. They are usually found in clusters on crater floors or in association with layered terrain. TAR sediments are likely derived from deflation of mass wasting deposits from nearby steep slopes or layered terrains. Consistent wind regimes over large areas and associations with other features such as LDDs suggest that TARs are not transient features. There is some correlation between TAR orientation and GCM wind directions. Equatorial TARs have distinct morphology (barchan-like) and appear to be old/inactive. TARs associated with intracrater dunes are younger/more active. TARs appear only to be active when associated with large dunefields. This is consistent with an interpretation that TARs are granule ripples and are only active if they have a constant supply of saltating material.

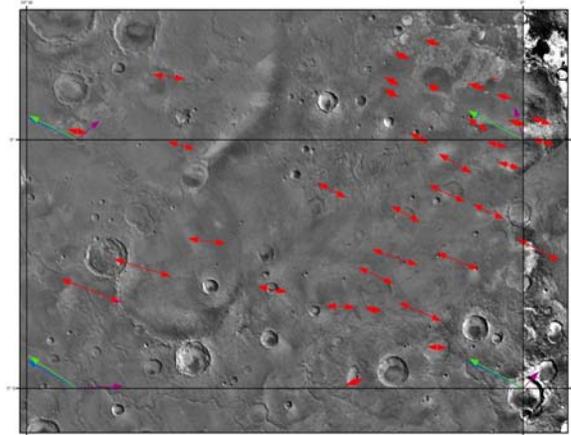


Figure 3. Red lines drawn normal to crestline orientations of TARs, green and blue lines show GCM directions [6], in the Terra Meridiana region.

**References:** [1] Bourke, M.C. et al., LPSC XXXIII, Abstr. # 2090, 2003. [2] Wilson, S.A. and Zimbelman, J.R., J. Geophys. Res., 109 (E10), 2004. [3] Balme, M.R. et al., Geomorphology, 101, 703-720, 2008. [4] Balme, M.R., et al., J. Geophys. Res., 108 (E8), 2003. [5] Reiss, D., S. et al., J. Geophys. Res., 109 (E06), 2004. [6] Rafkin, S., Haberle, B. and Michaels, T., Icarus, 151: 228-256, 2001.