

FURTHER INVESTIGATIONS OF TRANSVERSE AEOLIAN RIDGES ON MARS. Daniel C. Berman¹, Matthew R. Balme¹, Joseph R. Michalski¹, and Timothy I. Michaels², ¹Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; ²SETI Institute, 189 Bernardo Avenue #100, Mountain View, CA 94043; bermandc@psi.edu.

Introduction: As noted first from Viking Orbiter images [1,2] and from Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) images [3,4], a population of aeolian bedforms exists that is morphologically and dimensionally distinct from Large Dark Dune (LDD) fields, being generally brighter than, or of similar albedo to, the surrounding terrain [3]. These features are significantly smaller than the LDDs, appear to form normal to local winds, and tend to have simple, transverse, “ripple-like” morphologies. Whether these small martian bedforms represent large granule ripples, small transverse dunes, or something entirely different is currently under debate, and so they have been designated “Transverse Aeolian Ridges” [5].

TARs are one of the most common landforms on Mars. As the smallest aeolian landforms observed from orbit, TARs are clearly important for understanding meso- and small-scale interactions between the surface and atmosphere. TARs are also indicative of the weathering and sediment transport regime on Mars and an understanding of their morphologies, morphometries, and composition can provide information on the composition, mobility, and availability of aeolian sediments on Mars. Moreover, the spatial distribution of TARs provides information about where on Mars aeolian sediments are concentrated. If we can determine if TARs were active only in the past, or whether TARs are mobile under today’s wind conditions, then we can begin to assess when and where TARs are/were active over Mars’ recent geological history. Thus TARs have the potential for being indicators/records of climate change on Mars.

Methodology: In this work we focus on the local/regional scale and thus have identified six regional study areas, each 5° by 5°, to investigate the behavior of TARs in detail; one in the northern hemisphere, three in the equatorial band, and two in the southern hemisphere. These study areas were chosen on the basis of high TAR content and good image coverage, based on results from our previous study [6,7]. All HiRISE, CTX, and MOC images for each study area have been downloaded from the PDS, processed in ISIS, and ingested into an ArcGIS database. By exploring sediment sources, climate, and local topography/geology as potential factors, we can constrain potential formation mechanisms.

Mapping of surficial deposits: Surficial sediment deposit maps of each study area are being produced to trace sediment from source to sink, and to investigate whether LDDs and TARs share sediment sources and pathways. We are mapping TARs in terms of morphology and morphometry. For each of the study areas we are mapping the surficial deposits with a focus on sediment pathways, sediment sources, and interactions/associations between TARs and LDDs. We are primarily using CTX data for this task. We are mapping 1) TARs (including orientations, degree of saturation and morphological characteristics as described by [6,7], 2) LDDs and dark aeolian deposits, and 3) possible sediment sources (e.g., layered terrains, dissected terrains or mass wasting deposits). These maps can then be used to examine sediment transport pathways, constraining sediment sources for TARs [8].

Preliminary maps for all six study areas have been produced. Results for two equatorial study areas are shown in Figs. 1 and 2. Initial examinations show that in the southern and northern mid-latitudes, TARs are mostly found near LDDs or dark deposits, indicating a related source, and nearly all of the deposits are found in local topographic lows, or sediment traps. The equatorial bands are heavily blanketed with TARs and show strong association with layered terrains.

Morphologic and morphometric analyses: We seek to determine what factors control the morphology and morphometry of TARs. We are producing Digital Terrain Models (DTMs) from HiRISE stereo pairs for each study area for analysis. We are taking height and width measurements for large numbers of TAR bedforms within each DTM to assist in calculating TAR volumes as a function of classification in order to estimate their sediment budget. We are also performing statistical analyses of TAR surface areas, degree of TAR clustering, and TAR equivalent sediment thickness and spacing. We are calculating the range of values, mean, and standard deviation for TAR lengths, widths, length/width ratios, heights, wavelength, and bedform saturation.

Two DTMs have thus far have been completed. Elevation profiles have been taken for 128 TAR bedforms thus far on the first DTM. The minimum TAR height for those measured is 1.25 meters; the maximum height is 4.41 meters; the mean height is

2.65 meters; the median height is 2.625 meters; and the standard deviation is 0.59 meters.

Comparison with local/regional meteorology, topography, and geology: By comparing the distribution of TARs with local/regional meteorology (using mesoscale regional climate models), topography, and geology within our study areas, we can search for correlation with climate model data and look for effects of local topography on wind speed/direction and TAR distribution. Output from preliminary MRAMS [9,10] simulations show strong correlations between TAR orientation and wind direction, as well as TAR presence and low wind shear stress, indicating that they are deposited mainly in sinks.

Compositional analyses: Compositional studies are being carried out using CRISM data to: 1) constrain the composition of TAR materials themselves, and 2) compare the composition of TARs to the composition of local LDDs and to local layered terrains (or other terrain units). We are testing the hypothesis that TARs are derived from local sources by comparing the composition of the bedforms to that of the terrain on which they rest. We are searching for evidence of compositional uniqueness within the dunes that could potentially contradict this hypothesis, and possibly be linked to a distal source region. Analyses thus far show little spectral diversity. So far, we have not found strong evidence for pyroxene or olivine in the dunes. Dark deposits appear spectrally similar to surrounding bedrock.

Crater counting and changes in high-resolution images: We are conducting crater count analyses on contiguous TAR fields, LDDs, and other associated terrains in HiRISE and CTX images in order to estimate formation ages. Investigating formation ages of TARs and TAR fields, and how they move and evolve over time can help us determine whether TARs are forming under current climate conditions, or are indurated/cemented and thus indicators of past climates. We are exploring how TARs evolve under the current climate regime by using time series of high-resolution images to search for changes in morphology and position of TARs with time. Thus far, no changes have been found.

Conclusions: Results to date show strong correlations between the presence of TARs, LDDs, and layered terrains. Mapping, atmospheric models, and compositional analyses show the aeolian deposits may share a common source.

References: [1] Thomas P. (1981) *Icarus* 48, 76-90. [2] Thomas P. et al. (1999) *Nature* 397, 592-594. [3] Malin M.C. and Edgett K.S. (2001) *JGR* 106, 23,429-23,570. [4] Wilson, S.A. and Zimbelman J.R.

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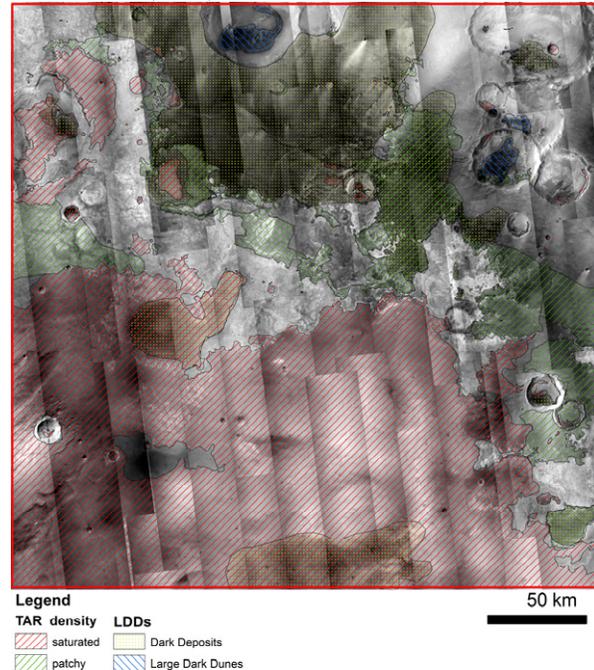


Figure 1. Study area 3 in Terra Meridiani showing mapped regions containing saturated and patchy TAR deposits, Large Dark Dunes, and dark aeolian deposits. Note association between deposits and layered terrains.

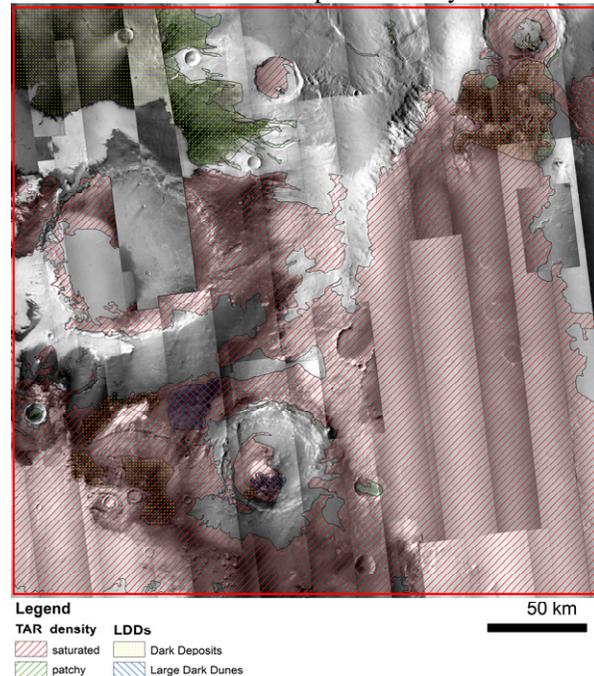


Figure 2. Study area 4 east of Terra Meridiani.