CHARACTERIZING THE PRESENT AND PAST AEOLIAN TRANSPORT ENVIRONMENTS IN MERIDIANI PLANUM. L. K. Fenton[1], T. I Michaels[1] and M. Chojnacki[2], [1]SETI Institute, 189 Bernardo Ave., Ste. 100, Mountain View, CA, USA 94043 (lfenton@seti.org), [2]Lunar and Planetary Lab, U.A., Tucson, AZ, USA.

Introduction: In the past decade, Mars has surprised the planetary community with the unexpected discovery of contemporary aeolian activity. Specifically, ripples and dunes have been found to migrate and change in volume in several different environments on the planet [e.g., 1-3], sand has saltated to the tops of rover decks [4-6], and *in situ* observations of wind streaks and rover tracks indicate that sand transport is an ongoing process modifying the martian landscape [7,8]. However, the timing of, duration of, and weather patterns driving sand saltation are not well constrained, nor is its context within recent climate shifts on Mars understood.

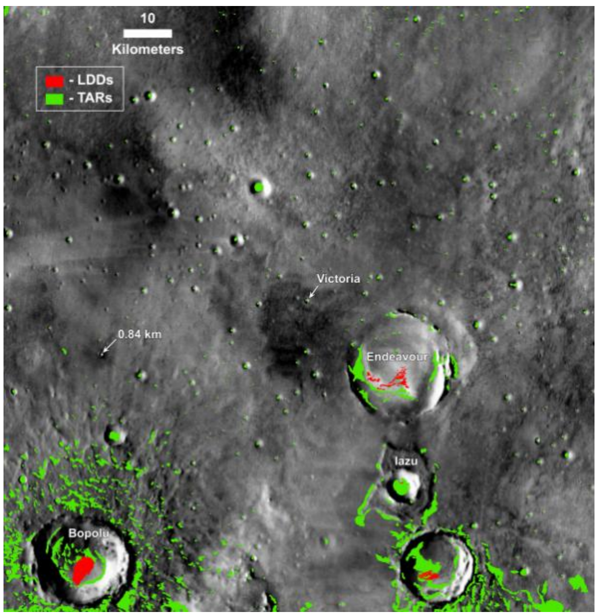

Figure 1. The study area in Meridiani Planum, showing the locations of TAR and LDD fields on a THEMIS daytime IR mosaic.

Meridiani Planum was selected as a study area for its plentiful and diverse aeolian features, including large dark dunes (LDDs), transverse aeolian ridges (TARs), plains ripples, and both bright and dark wind streaks. LDDs in Endeavour crater are currently migrating toward the southeast [9,10], but plains ripples [11,12] clearly indicate an ancient dominant wind blowing from the east that was last active ~50-200 ka [13]. The diversity of features and change in wind regime permits a more complete assessment of aeolian sedimentary history than is found in most locations on Mars. We present three significant results from a comprehensive study of aeolian features in a 2ºx2º area in Meridiani Planum, centered near Victoria crater (see Fig. 1). This work is part of an MDAP grant to decipher the aeolian environment in greater Meridiani Planum, including monitoring of LDD activity [e.g., 10] and atmospheric modeling [e.g., 14].

Method: ArcGIS 10.1 (ESRI) has been used to map the relevant aeolian features in the study area, using HiRISE images, where available, and CTX images were used elsewhere. To date, this includes the locations of LDDs and TARs, the orientations of wind streaks (bright, dark, and ripple/TAR [12]), and crestline orientations of LDDs, TARs, and selected regions of plains ripples.

1. Wind Streaks:

Because they are active today, bright and dark wind streaks provide the best wind direction indicators available. Bright streaks are typically oriented towards the NW or SE, but dark streaks are almost exclusively oriented towards the NW (see Fig. 2).

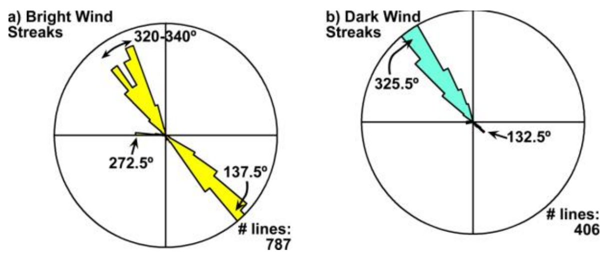

Figure 2. Orientations of bright and dark streaks in the study area.

Discussion. In situ studies from Opportunity indicate that bright streaks are made of dust that has likely been transported some distance [e.g., 15], whereas the Victoria crater dark streak is composed of dark basaltic sand sourced from within the crater [7]. Thus, the present-day net transport of saltated dark grains on the plains appears to be toward the NW. This finding contrasts with both the observed LDD migration toward the SE [9,10] and dune morphology from the two other LDD fields in the study area (which have SE-pointing barchanoid dunes similar to those in Endeavour crater).

The difference in environment within craters and on the surrounding plains appears to be enough to influence sand-moving wind patterns in the region. Crater rims may enhance or deflect incident winds; planned mesoscale atmospheric modeling may shed some light on this dichotomy. *The main message here is that neither LDDs nor wind streaks alone may fully describe the sand-moving winds in any given area on Mars*.

2. Crater gradation:

Based on degradation state and comparison with other craters, a nearly filled, 40 m diameter crater named Vostok was assigned an approximate age of 10 Ma [16]. Opportunity traversed by many such craters, including several that have either none or a slight positive relief (see Fig. 3). With a vertical accuracy of ~35 cm, relief must be >~1 m to be clearly identified on a HiRISE DTM; this places an upper limit on the height of inferred inverted topography that is apparent in rover images but not visible in the DTM.

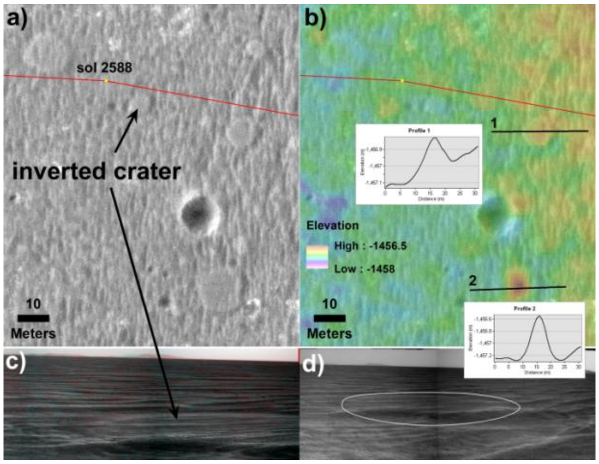

Figure 3. a) Sol 2588 of Opportunity's traverse. b) The same region with overlain HiRISE DTM (DTEEC_018701_1775_018846_1775_U01), c) Pancam mosaicked anaglyph and d) Navcam mosaic of inverted crater.

Discussion. These craters exhibit an erosional state beyond that of the ~10 Ma craters. Their crater rims have been completely worn away, they are completely filled by sediment, and in some cases the surrounding plains have eroded down farther than the former crater interior. Figure 4 shows a model for the development of these inverted craters, in which the surrounding plains erode faster than armoring ripples [as shown by 13, 17]. Given the mean erosion rate in Meridiani Planum (1-10 nm/yr) [18], and assuming that the tallest inverted features (height ~1 m) have undergone no net erosion, *these inverted craters may be dated to ~0.1-1 Ga*.

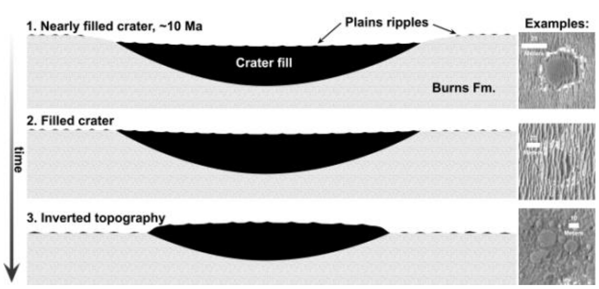

Figure 4. Proposed sequence of aggradation for <100 m craters older than ~10 Ma, from 1) nearly-filled, to 2) filled, to 3) inverted.

3. Dating aeolian activity:

An unnamed, 0.84 km diameter crater (Fig. 5a), located ~50 km west of Endeavour crater, was dated to ~200 ka by [13]. Plains ripples ~9 km south of this crater have partially migrated over secondaries from this impact, indicating limited activity since the crater's formation. Apart from partial burial by an ejecta lobe (Fig. 5b), the two TAR fields that lie within 4 km of this crater are unscathed by the impact (Fig. 5b, c) – despite being surrounded by ejecta and secondary craters. A small TAR field has formed within the crater, but plains ripples have not reformed on the ejecta.

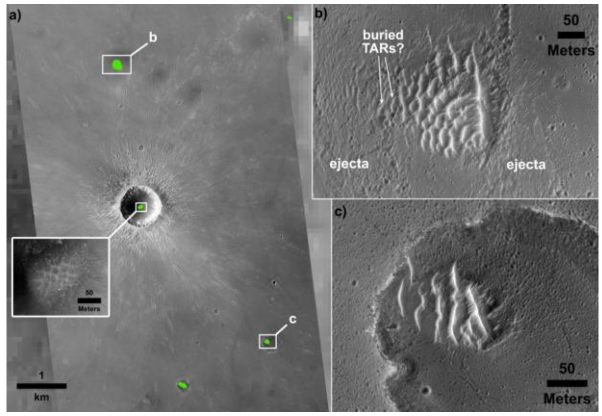

Figure 5. a) 0.84 km crater dated to ~200 ka by [13], b) and c) show TAR fields surrounded, but unaffected by, impact ejecta.

Discussion. Partial burial indicates the TAR fields predate the impact, but the lack of superposed secondary craters indicates they have been active since the impact. Comparing the relative reconstruction rate of plains ripples and TARs, *the Meridiani Planum TARs appear to be more active than the plains ripples*.

Future Work: Mapping efforts will continue, as will acquisition of HiRISE repeat imagery to identify present-day wind patterns in Meridiani Planum. Higher resolution atmospheric modeling (both temporally and spatially) has begun, with preliminary results showing improvement over previous attempts to understand the present-day wind regime in Meridiani Planum.

References: [1] Sullivan et al. (2008) *JGR, 113*, doi:10.1029/2008JE003101. [2] Silvestro et al. (2010) *GRL, 37*, doi:10.1029/2010GL044743. [3] Bridges et al. (2013) *Aeol. Res., 9*, doi:10.1016/j.aeolia.2013.02.004. [4] Greeley et al. (2006) *JGR, 111*, doi:10.1029/2005JE002491. [5 Landis et al. (2006) *LPS XXXVII*, Abst. #1932. [6] Vaughan et al. (2010) *Mars*, doi:10.1555/mars.2010.0005. [7] Geissler et al. (2008) *JGR, 113*, doi:10.1029/2008JE003102. [8] Geissler et al. (2010) *JGR, 115*, doi:10.1029/2010JE003674. [9] Chojnacki et al. (2011) *JGR, 116*, doi:10.1029/2010JE003675. [10] Chojnacki et al. (2010) *LPS XLV*, Abst. #2775. [11] Sullivan et al. (2005) *Nature, 7047*, doi:10.1038/nature03641. [12] Silvestro et al. (2014), this meeting. [13] Golombek et al. (2010) *JGR, 115*, doi:10.1029/2010JE003628. [14] Michaels (2014) *LPS XLV*, Abst. #2897. [15] Yen et al. (2005) *Nature, 7047*, 10.1038/nature03637. [16] Golombek et al. (2012) *LPS XLIV*, Abst. #2267. [17] Sullivan et al. (2007) *LPS XXXVIII*, Abst. #2048. [18] Golombek et al. (2006) *JGR, 111*, doi:10.1029/2006JE002754.