INVESTIGATING THE SOURCES AND ORIGINS OF DARK SAND IN AEOLIS DORSA, MARS: EVIDENCE FOR LOCAL DARK SEDIMENT PRODUCTION. A. S. Boyd[1] and D. M. Burr[1]. [1]Department of Earth and Planetary Sciences, The University of Tennessee, Knoxville, Knoxville, TN (aboyd21@utk.edu).

Introduction: Dark sand deposits occur at all latitudes on the Martian surface [1, 2]. These deposits occur in the form of sand seas, sand sheets, or dune fields, and are located in areas like crater basins, valley floors, southern highlands plains, and within the equatorial region [1, 2]. The sources of sand in some of these regions have been inferred via analysis of paleo-wind indicators, comparison of mineralogies of sands and sources, and climate modeling. Such analyses identified the following sand sources: (a) crater walls in the southern highlands [3]; (b) basal units of the north polar layered deposits (nPLDs) [4, 5]; and (c) wall rock in Valles Marineris [6]. These sand sources are all sedimentary (secondary), leaving outstanding the question of primary igneous origin(s) of these dark sand deposits. One hypothesis addressing the origin of Martian sand is that volcaniclastic deposits are a primary origin of dark sand [e.g., 7]. Terrestrial analogs of volcaniclastic units sourcing sand support this hypothesis [7, 8]. Friable layered deposits, some of which are hypothesized to be volcaniclastic, are widespread on Mars [e.g., 9] and comprise a large potential sand source. However, sand generation has yet to be observed or inferred from any such deposit.

To test this hypothesis, we conducted a case study in a locality where sand overlies bedrock consisting of a hypothesized volcaniclastic deposit, the Medusae Fossae Formation (MFF) in the Aeolis Dorsa (AD) region of Mars (Fig. 1). Here, geospatial sand distribution, inferred paleo-wind transport directions, and observations of bedrock erosion provide information on likely sources of dark sand in AD. This study identifies at least two different apparent AD sand sources: (1) bedrock that is morphologically similar to the southern highlands; and (2) the MFF itself, which may also be a primary sand origin.

Data and methods: We mapped sand distribution and recorded paleo-wind indicators (here, aeolian scours [10]) in ArcMap on a 6-m/px-resolution base map of visible-wavelength images from the Mars Reconnaissance Orbiter Context Camera [CTX; 11]. High-Resolution Imaging Science Experiment [HiRISE; 12] images are of sufficiently high resolution (~25 cm/px) to study investigate potential sand generation via *in situ* bedrock erosion.

Support for sources: Sand distribution provides information on transport history and likely regional or local source(s). For example, sand distribution and scour orientations suggesting possible transport from a nearby region, coupled with reasonable transport pathway(s) (that is, topography and surface characteristics allowing for aeolian sediment transport), would support an external source. Alternatively, topographic obstacles limiting the reasonable potential for sand to be transported from anywhere outside its immediate location would support a local or *in situ* source. The MFF as a sand source would require support for a local source for sand that occurs on and around the two lobes of the MFF in AD, Aeolis and Zephyria Plana (AZP).

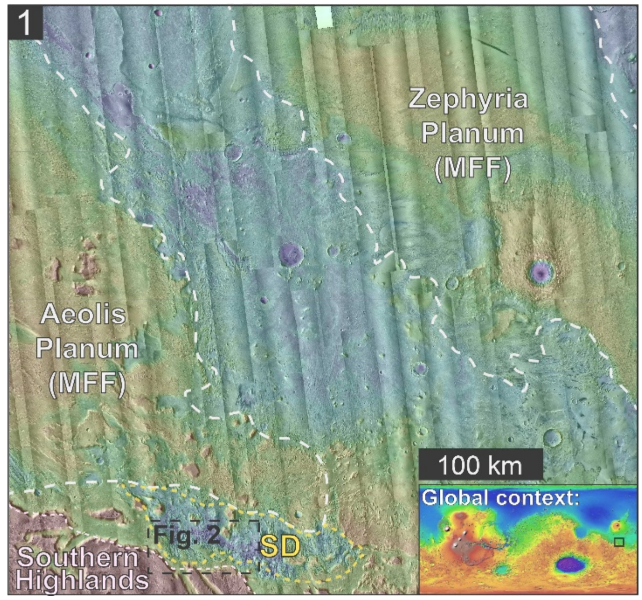

Figure 1. Aeolis Dorsa, Mars. Text and dashed lines show regions of interest referenced in text. 'SD' refers to the southern depression, a region ~500 m lower in elevation than elsewhere in Aeolis Dorsa.

Methods: We mapped sand deposits at a scale of ~1:100,000 and recorded deposits as polygons in ArcMap. AD sand deposits are often dark-toned, but some light-toned (inferred dust-covered) deposits are present (identifiable via smooth surfaces indicative of loose sediment, and via co-occurring echo dunes). We categorized sand deposits according to their tone and whether they occur as sheets or in yardang troughs. At a scale of 1:24,000, we recorded all scour orientations in sand as linear features. We grouped sand deposits and aeolian scours by location using the 'hierarchical cluster' tool in SPSS Statistics 25.

We mapped instances of apparent erosion of dark bedrock layers to loose sediment (identifiable as dark-toned talus slopes on bedrock block flanks) as point features in ArcMap. HiRISE images allowed us to identify additional localities with small-scale *in situ* dark sediment production, although more such localities likely exist beyond those seen in HiRISE. We mapped these HiRISE localities as a separate point class due to the different data resolution.

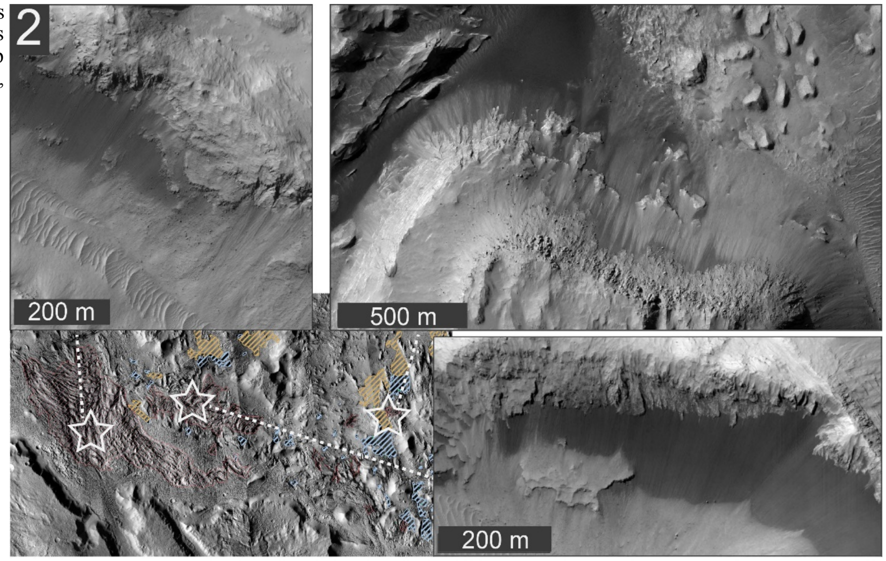

Figure 2. Bedrock erosion in the SD. Talus slopes originating from bedrock layers appear to be dark sand. Clockwise from top left: ESP_039240_1730, ESP_038066_1725, ESP_051780_1725. Source: NASA/JPL/UA.

Results: Sand clusters preferentially in the southern depression (SD) and on AZP peripheries. Sand distributions are inconsistent with obvious transport pathways based on topography, surface roughness and yardang orientations. Together with rough topography throughout AD, the lack of transport pathways provides no support for sand transport from any region outside AD. Inferred transport wind directions appear to show deflection of winds around topographic highs, suggesting topographically controlled sand transport.

Erosion of bedrock to dark sediments is most prevalent in the southern depression (SD), which exhibits over 100 instances of dark talus slopes extending downslope to dark sand deposits. In many cases, dark slopes abruptly end where lighter-toned slopes begin. Figure 2 shows examples of erosion, featuring talus slope morphology that is nearly ubiquitous in the SD.

Multiple localities on AZP contain dark sand found in small bedrock alcoves (e.g., figs. 3, 4). In some cases, apparent talus slopes extend down from outcrops directly above these dark sand deposits.

Implications: The MFF is light-toned, but on AZP appears to be producing dark sediments. On Earth, production of darker sediments from lighter-toned bedrock occurs in the Campo Piedra Pomez (CPP) ignimbrite of Argentina [8], in which darker sediments reflect the composition of CPP material that has since been eroded. A similar phenomenon may be occurring in the MFF, evidenced on AZP by these alcoves of apparent dark sand production from discontinuous dark layers of the MFF. The volume of dark sediment produced in these alcoves is small relative to the total volume of sand mapped in AD, so these erosional alcoves do not explain the origin of all dark sand in AD. These alcoves do, however, offer a 'proof of concept' that the MFF has the potential to produce dark sediment, even in the apparent absence of dark bedrock.

References: [1] Hayward R. K. et al. (2007) *JGR*, 112, E11007. [2] Hayward R. K. et al. (2014) *Icarus*, 230, 38-46. [3] Tirsch D. et al. (2011) *JGR*, 116, E03002. [4] Langevin Y. et al. (2005) *Sci*, 307, 1584-6. [5] Fishbaugh K. E. et al. (2007) *JGR*, 112, E07002. [6] Chojnacki M. et al. (2014) *Icarus*, 232, 187-219. [7] Edgett K. S. and Lancaster N. (1993) *J. Arid Env.,* 25, 271-297. [8] de Silva S. L. et al. (2013) *GSAB*, 125, 1912-1929. [9] Kerber L. et al. (2012) *Icarus*, 219, 358-381. [10] Bishop M. A. (2011) *Geomorphology*, 125, 569-574. [11] Malin M. C. and Edgett K. S. (2001) *JGR*, 106, 23429-570. [12] McEwen A. S. et al. (2007) *JGR*, 112, E05S02.

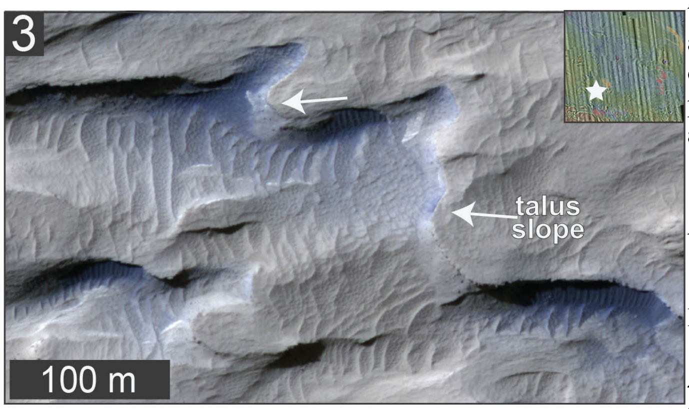

Figure 3. Dark sediments in MFF alcoves on Aeolis Planum in HiRISE image ESP_035310_1740*. Talus slopes marked with white arrows (refer to full HiRISE image for additional talus slopes and dark sediments not shown in this excerpt).

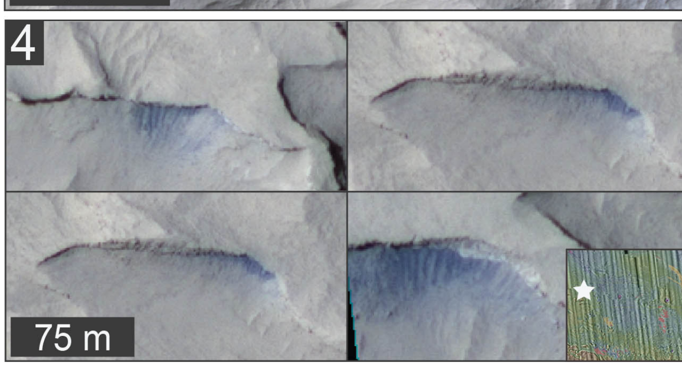

Figure 4. Dark sediments in northern Aeolis Planum, within 20 km of one another (same HiRISE image, ESP_006815_1780*). Additional dark sediments can be seen in full HiRISE image. Scale is the same for all four excerpts.

**Source: NASA/JPL/Univ. of Arizona.*