CONSTRAINING SOURCES OF SAND IN THE AEOLIS DORSA REGION, MARS, VIA SAND DUNE MORPHOLOGIES AND SAND DISTRIBUTIONS. A. S. Boyd[1] and D. M. Burr[1], [1]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN. (aboyd21@utk.edu)

Introduction: Sand occurs at all latitudes on the Martian surface [1, 2, 3], and its origin(s) remains a significant question in Martian geology. While some local sources of sand have been identified [e.g., 4, 5, 6], both the geographic sources and the geologic origins of most sand deposits on Mars remain unresolved. This lack of resolution is due, in part, to the fact that sand is often located without obvious local sources, indicating that the source of sand is either distal or cryptic. One potential sand source is volcaniclastic deposit weathering [7], a hypothesis based on terrestrial observances of volcaniclastic materials weathering to sand [7]. Although this phenomenon is postulated to occur on Mars, the weathering of volcaniclastics to sand has yet to be observed on the Martian surface.

This research is a case study in an area with sand deposits, underlain by (hypothesized volcaniclastic) bedrock that may serve as a geological origin for the sand deposits. This case study aims to identify the geographic *source(s)*, and/or geologic *origin(s)*, of sand in the Aeolis Dorsa (AD) region.

Background: The AD region (Fig. 1a) comprises the westernmost extent of the Medusae Fossae Formation (MFF), a laterally extensive, light-toned, layered deposit just north of the highland-lowland boundary (HLB) [e.g., 8, 9]. The geography surrounding the AD region includes Elysium Mons to the north, the Cerberus plains to the north-and-east, and the southern highlands to the south. Elysium Mons, the Cerberus plains materials, sedimentary material from the southern highlands, or the underlying bedrock could all serve as geographic *sources* of sand in AD. The primary geologic *origin* of the sand—i.e., the volcanic or volcaniclastic bedrock that constitutes the original material from which sand is formed—may be volcanic material from Elysium Mons, the Cerberus plains, or the underlying MFF. Materials from the ancient southern highlands may provide a *source* for sand in AD, but because the southern highlands materials may be sedimentary in origin [e.g., 10], this region cannot provide a certain primary sand *origin*.

Geographic sand sources are often recorded in sand deposit morphologies that can provide evidence of wind emplacement direction (see Fig. 1). In AD, sand deposit morphologies include transverse dunes and scour marks. Transverse dunes' stoss and lee sides may provide information regarding unidirectional winds, while even symmetrical transverse dunes indicate bidirectional winds (normal to dune long axes). Scour marks are erosional features where material is deflated from the upwind side of an obstacle, forming a moat around all upwind sides of that obstacle [11]. Sand in the AD region also occurs as bright sand sheets. Such light-colored sand sheets are inferred based upon surface topography: flat, smooth, with aeolian features (i.e. small dunes, scour marks around obstacles).

Hypotheses: The goal of this study is to provide an initial constraint on AD sand source(s). The geography surrounding AD allows four potential sources of sand – three regions from which sand may have been transported, and/or in situ bedrock erosion:

1. In situ weathering of the MFF: In this scenario, MFF bedrock material in AD weathers to loose sediment. Both dust- and sand- sized particles are liberated as abrasion occurs. Dust-sized particles are removed via deflation, whereas sand-sized particles are moved via saltation within the region.
2. Elysium Mons: Volcaniclastic deposits or effusive lava flow materials on the Elysium Mons edifice, north of the AD region, may serve as source(s) and/or origin(s) for sand in AD. These deposits may be weathered to loose sediment. In this scenario, katabatic winds would facilitate loose sediment transport from Elysium Mons to the basinal region in between Aeolis & Zephyria Plana. Such transport would result in the formation of aeolian morphologies indicative of southward wind transport directions, e.g., barchan dunes with S-pointing horns.
3. Cerberus plains lavas: The Cerberus Plains, located to the east of AD, consist of extensive lava flows [12] where recent, and potentially ongoing, seismic activity is posited to occur [13]. The potential for weathering of the plains to sand-size particles, via "Marsquakes" [13], impact cratering, or fissuring [12, 14] offers a viable extensive source region for sand in Aeolis Dorsa. Transport from the Cerberus Plains would result in higher sand concentrations at lower elevations on the eastern side of Zephyria Planum and any aeolian features (dunes, scour marks) would indicate westward wind transport directions.
4. Southern highlands: In this hypothesis, dark sand occurs on the southern highlands plains, to the south of AD [1, 10]. Sand is then transported northward across the HLB into the lower-elevation AD region. If sand in AD is indeed coming from the southern highlands, a higher concentration of sand should occur in the large topographic trough (hereafter called "southern trough", Fig. 1a), with aeolian features indicating emplacement from the south.

Data and methods: This study tests various hypotheses for source(s) of sand within AD, via determination of emplacement wind direction(s), and the use of high-resolution imagery to identify in situ erosion of bedrock to dark sand. Emplacement wind direction(s) and relative timing of sand and dust movement will be determined using sand morphologies (i.e. sand sheets, dunes), and dust cover over sand, respectively. Sand distributions will be mapped on a basemap of images from the Mars Reconnaissance Orbiter (MRO) Context Camera [CTX; 15]. With a resolution of 6 m/px, the CTX basemap provides high-resolution imagery to map and analyze mesoscale features. Mars Orbiter Camera [MOC; 15] narrow angle (NA) images and High-Resolution Imaging Science Experiment [HiRISE; 16] images permit analysis of individual feature morphologies in high dark-bedform-density regions.

Preliminary results and implications: Scour marks occur along the western margin of AD, and may wrap around the SW, W, N and E sides of obstacles (Fig. 1b); NE-, SW- and NW- oriented scour marks occur within 2 km of one another. To date, only transverse dunes have been identified. Transverse dunes occur predominantly in inter-bedrock trenches (Fig. 1d), oriented normal to trench long axes, but variable in azimuthal orientation.

The sand-rich southern trough (Fig. 1a) contains blocks of strata that expose layers of low-albedo, bluish coarse-grained rock sandwiched between thicker, lighter-toned layers that erode to finer-grained materials (Fig. 1c). In many places, material from the low-albedo layers is clearly eroding to sand-size particles that coalesce in trenches within the southern trough (Fig. 1c). Thus, these dark, coarse layers are a certain source of sand in the southern trough. Although the bedrock blocks sourcing sand in the southern trough have been mapped as the MFF [17, 18], this bedrock tends to form massifs similar to those of the southern highlands materials. The similarity between these blocks and southern highlands massifs elsewhere along the HLB [19] indicates that this area may be composed of southern highlands materials of uncertain origin [e.g., 10]. If these blocks are remnant southern highlands massif material, we can infer that although erosion of dark layers in the massif blocks is the *source* for most of this sand, these dark layers are *not necessarily a primary origin* of Martian sand.

Future work: We will continue to map this area, inferring wind emplacement from sand morphology and constraining sand sources via geospatial distribution. Results of this work will be used in conjunction with spectral analyses & climate models to constrain likely sources of sand in Aeolis Dorsa.

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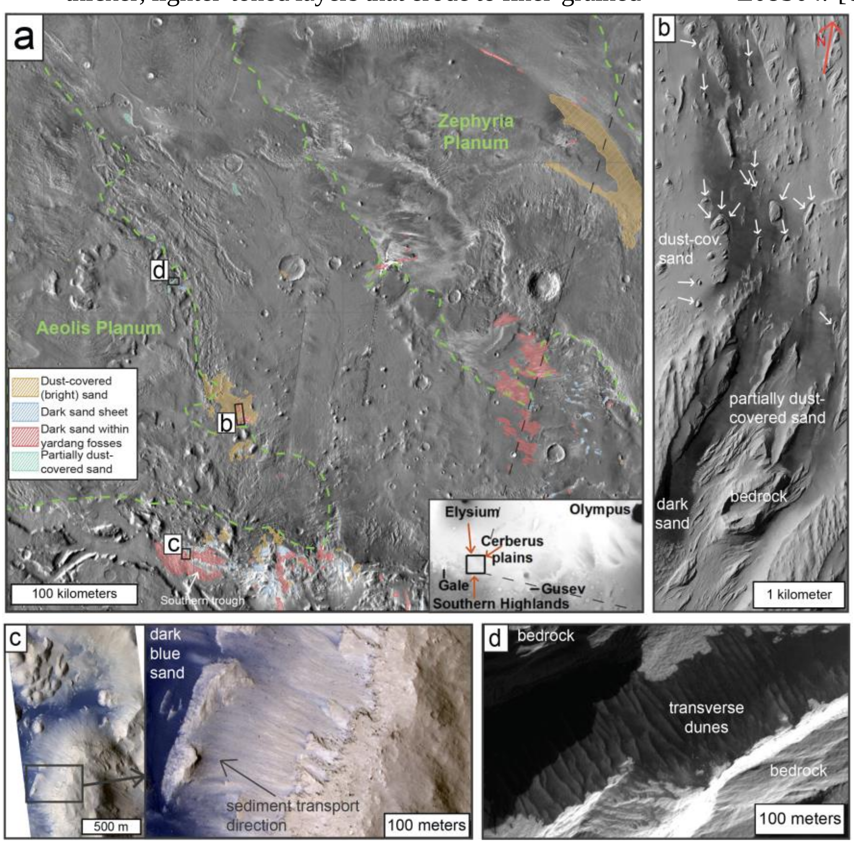

Figure 1. a) Study area with preliminary sand deposits. Aeolis & Zephyria Planum outlined in green; inset image shows poss. external sand sources, with orange arrows indicating inferred wind emplacement directions. b) Co-occurring dark sand, partially dust-covered sand, and dust-covered sand (presence inferred from scour marks.) All white arrows around scours indicate inferred wind directions. c) Massif layers weathering to dark sand in the southern trough. Inset shows detail, incl. downslope sediment transport into a trench. d) Low-albedo transverse dunes in trench on Aeolis Planum.