INTRACRATER SEDIMENT TRAPPING AND TRANSPORT IN ARABIA TERRA, MARS T. C. Dorn and M. D. Day, Department of Earth, Planetary, and Space Sciences, University of California Los Angeles, Los Angeles, CA 90095, USA, (planetarytaylor@g.ucla.edu)

Introduction: Substantial volumes of sediment have been generated throughout Mars' history, as evidenced by aeolian and fluvial depositional features on the surface (e.g. modern dunes, delta deposits, aeolian sandstones) [1,2]. Transport of sediments on the modern martian surface is dominated by aeolian processes, resulting in depositional features such as migrating dunes [3,4,5] and wind streaks [6], the morphologies of which capture the direction of their formative wind. While these depositional features dominate the modern martian landscape, preserved aeolian sandstones have been observed by the Mars Science Laboratory (MSL) rover Curiosity within Gale crater [7] and with the Mars Exploration Rover (MER) rover Opportunity within Endeavour crater [8], demonstrating that craters have acted as depocenters for sediment accumulation for a substantial portion of the planet's history.

Dune fields on Mars often form in topographic lows such as crater basins and valleys [9]. In topographically trapped dune fields, sediment accumulates at the base of the topographic obstacle (e.g. crater walls) creating a "terminal" dune field [10]. The position of terminal dune fields and their morphology provide observable indications of the local wind regime. Furthermore, terminal dune fields provide surface evidence of the interactions between aeolian sediment transport and topography on Mars.

Wind streaks similarly reflect interactions between wind and topography and are identified by their albedo contrast with the surrounding terrain [6]. Bright albedo streaks have been previously interpreted as formed by dust deposition whereas dark albedo streaks have been previously interpreted to be erosional features created by saltating grains [6]. In this work, we interpret surface-wind interactions from geomorphic evidence in craters with interior terminal dune fields in Arabia Terra to understand how crater geometry determines whether sediment is trapped or transported out of craters.

Methods: To understand the dynamics of sediment transport into and out of craters, we identified craters >10 km in Arabia Terra where terminal dune fields were present (Fig. 1). Dune fields were considered terminal if they were dominantly towards one side of the crater, in close proximity to the crater wall, and of sufficient size. Crater diameters, dune fields, and interpreted wind directions were mapped using ArcMap 10.6 on a mosaic of images from the Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) [11] with a resolution of ~6 m/px [12].

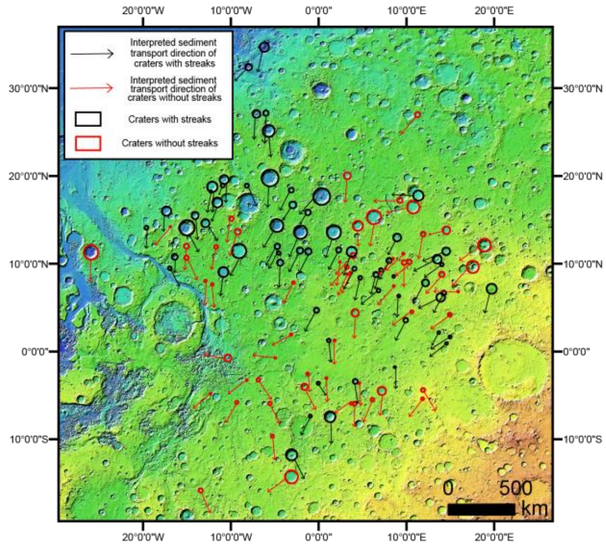

Fig. 1. *Craters with terminal dune fields and their interpreted wind directions in Arabia Terra, Mars. Black circles show studied crater basins that have wind streaks. Red circles show studied craters that do not have wind streaks. The red and black arrows associated with the craters show the interpreted prevailing wind directions based on dune morphology, position of terminal dune field within the craters, and/or wind streak orientation.*

Craters were categorized into two groups: those with wind streaks emanating from the crater rim in the interpreted downwind direction (Fig. 2a), indicating that there is active sediment transport out of the crater, and those with no downwind wind streaks (Fig. 2b), indicating no sediment transport out of the crater. Prevailing wind directions were interpreted and mapped using dune morphologies, their position within the craters, and wind streak orientation. Crater wall slopes on Mars were measured downwind of each terminal dune field using elevation data from the Mars Orbiter Laser Altimeter (MOLA) 128 ppd interpolated elevation map with a spatial resolution of ~463m/px [12,13].

Results: We identified 121 craters in Arabia Terra with terminal dune fields within their interior. From this total, 56 craters have wind streaks emanating from the crater rim onto the surrounding plains, 57 craters have no wind streaks associated with the crater, while eight craters were placed in an 'intermediate' category because low albedo features were observed along the crater walls. Within the 56 craters that have wind streaks associated with them, 40 had dark wind streaks, whereas the remaining 16 had a bright wind streaks.

Crater diameters and slopes were measured in all 121 craters. The range of diameters measured showed that dark wind streaks, light wind streaks, streaks in the 'intermediate' category, and craters with no wind streaks were not limited to a particular crater diameter. Crater slopes showed significant difference between craters with wind streaks and those without. Craters where sediment was interpreted to be actively transported over the crater rim have a much lower average slope (9.5° ±5.5°) compared to craters without an associated wind streak (17° ±5.6°; Fig. 3). A two-sample t-test was conducted to determine whether craters with interpreted active and inactive transport sampled the same or different distributions of crater wall slope populations. At a 95% confidence, measured crater wall slopes for craters with both light and dark wind streaks were statistically distinct from the population of crater wall slopes from craters with no wind streaks. From this we interpret a threshold crater wall slope of ~15° at which craters transition from being sediment sources to sediment sinks. The dominant prevailing wind direction in the study area based on the morphology of the dunes, position of a dune field within a crater, and the orientation of wind streaks was towards the southwest, consistent with previous interpretations [14] (Fig. 1).

Conclusion: From the 121 craters we studied in Arabia Terra with terminal dune fields, our results show that craters with wind streaks have lower crater wall slopes (9.5° ±5.5°) compared to crater wall slopes without wind streaks (17° ±5.6°). These results show that crater wall slopes play a dominant role in sediment transport out of a crater basin. We interpret a threshold value of downwind crater wall slope for which a crater transitions from being a net sediment sink to a net sediment source. The slope wall angle at which this transition occurs is somewhere between 10° and 20 ° in the region of overlap between the studied distributions.

References: [1] Edwards C.S. et al., (2009) *JGR, 114,* 1-18. [2] Kocurek G. and Ewing R. C. (2012) *Sedimentary Geology of Mars,* 151–168. [3] Fenton L.K. (2006) *GRL, 33,* 1-5. [4] Silvestro et al., (2010) *GRL, 37,* 5-10. [5] Chojnacki M. et al., (2017) *Mars: Aeolian Research 26,* 73-88. [6] Veverka J. et al., (1981) *Icarus, 45,* 154-166. [7] Milliken R.E. et al., (2014) *GRL, 41,* 1149-1154. [8] Hayes A.G. et al., (2011) JGR, *116,* 1-17. [9] Breed C.S. et al., (1979) *JGR 84,* 8183. [10] Hesse R. (2009) *Quaternary Research , 71,* 426-436. [11] Malin M.C. et al., (2007) *JGR, 112,* 1-25. [12] Dickson J.L. et al., (2018) *LPS 49, 10,* 2480. [13] Albee A.L. et al., (2001) *JGR, 106,* 23291-23316. [14] Smith D.E. et al., (2001) *JGR, 106,* 23689-23722.

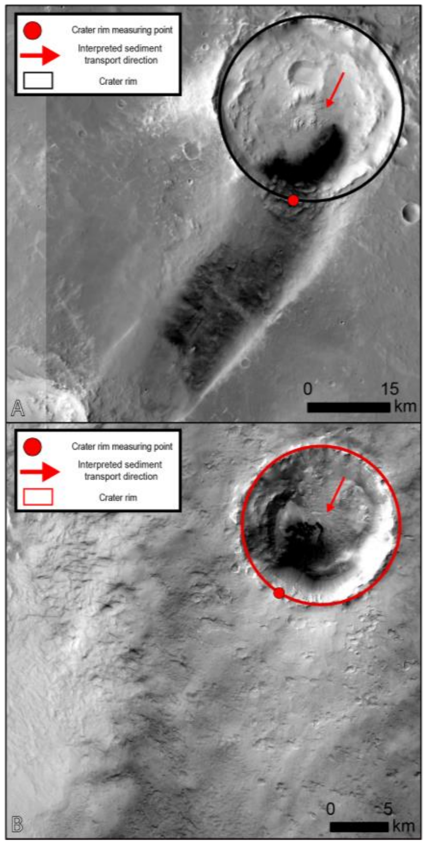

Fig. 2. *Types of craters in this study.* ***(a)*** *CTX image mosaic of a crater with a terminal dune field (dark region in crater interior), showing the crater rim, outlined in red, and interpreted downwind sediment transport forming a wind streak. Centered on 2.83° E, 9.75° N.* ***(b)*** *CTX image of a crater with a terminal dune field (dark region in crater interior) showing the crater rim, outlined in red, without a wind streak emanating from the crater rim. Centered on 356.74° E, 0.78° N.*

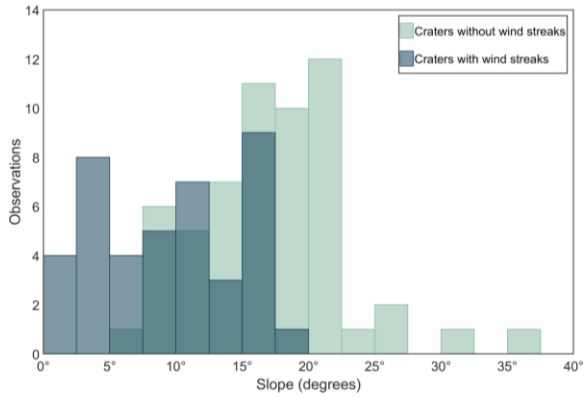

Fig. 3. *Histogram of crater wall slopes measured in craters with and without downwind wind streaks. Craters with wind streaks, and therefore interpreted to exhibit transport of sediment out of the crater, are skewed towards lower crater wall slopes while craters without streaks and interpreted to have no extra-crater transport are skewed towards more steeply inclined crater wall slopes.*