CLASSIFICATION OF THE AEOLIAN SEDIMENTARY SYSTEMS AT HERSCHEL CRATER, MARS.

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Introduction: Impact craters are the dominant long-term sedimentary sink for wind-blown sediments on mars [1,2]. They contain an abundance of modern sedimentary features, and the sedimentary rock record indicates that aeolian sediments have been depositing in crater basins since at least the early Hesperian [3,4]. We explore the hypothesis that basin geometry is a primary control on the type and distribution of aeolian features that accumulate with the potential to become preserved in the martian rock record. As a type example, we map aeolian features across Herschel Crater, a well-studied crater containing a range of aeolian features [5].

Methods: Using the Mars Reconnaissance Orbiter Context Camera (CTX) image mosaics [6] we classified aeolian features across Herschel crater. We overlaid ~ 4 x 4 km grid across the entire crater, which corresponds to the spatial resolution of a mesoscale climate model used to examine wind patterns across the crater. [see Young et al. 2023 LPSC]. We visually classified primary, secondary, and tertiary aeolian features within each grid cell. The classes used were asymmetric barchanoid, barchan, barchanoid, dome, drift, linear, network, ripple, sand sheet, streak, and transverse. A bearing was recorded that approximates aeolian transport direction in each cell.

Results: We determined on the abundance of aeolian features in the crater and created a map of the transport directions across the crater (Fig 1). We examined the relationship between the classes, vector orientation, the position outside and within the crater topography. Sand sheets are the primary feature compromising 64.29% of all the primary features in mapped grid cells. Dune fields of various types make up 15.74% of cells throughout the crater. The remainder of the cells contain drifts at 11.01%, streaks at 3.51% and ripples at 5.45% as primary features. Dune fields are predominantly asymmetric barchanoids, which make up 33.33% of dune cells mapped. Regular barchanoids make up 29.17%, isolated barchans 19.16 transverse dunes 7.33%, network dunes 5.83%, domes 3.51% and linear dunes 1.67% (Fig. 2). Figure 1 shows transport is dominantly north to south consistent with the regional wind directions. Transport is most N-S in the

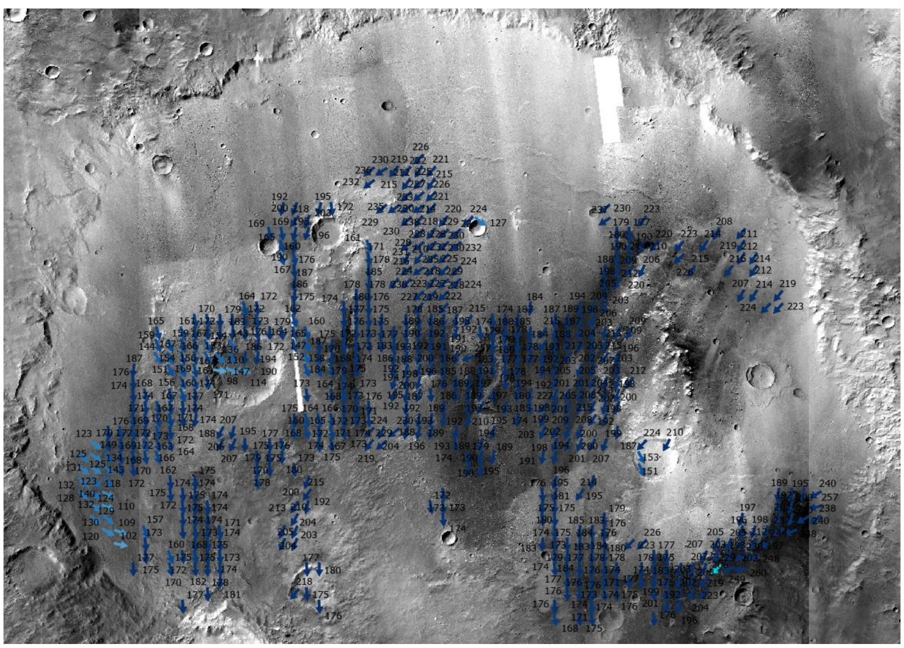

Figure 1 Herschel crater CTX image overlain with bearings in the direction of aeolian sediment transport

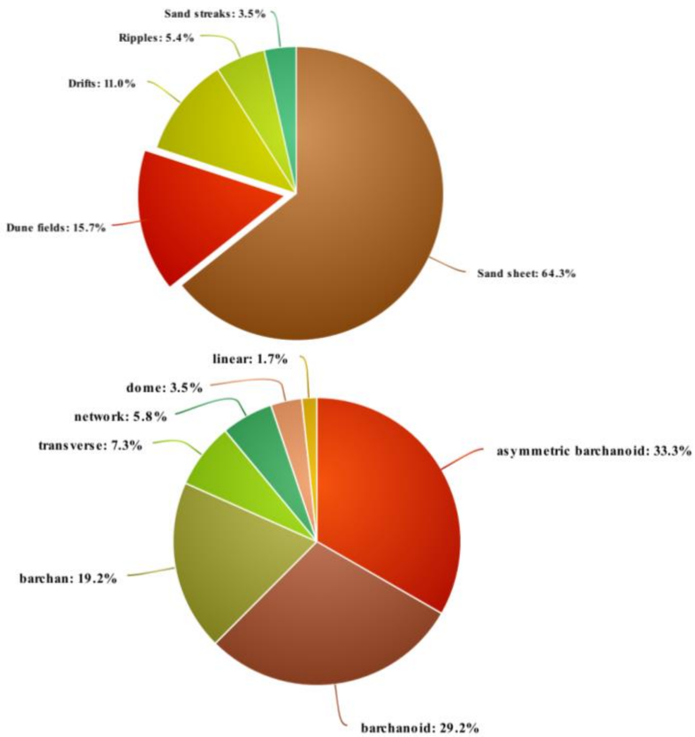

Figure 2: Pie charts showing the distribution of primary aeolian features (top) and dune types (bottom)

center of the crater and bears toward the interior near crater walls. Transport bearings are highly variable around irregular topography associated with the crater walls and interior structure. Areas lacking bearing measurements were typically sand sheets that lacked directional features.

Discussion: Aeolian feature type, dune type, and transport direction is strongly influenced by topography throughout the crater. Dune fields most commonly form where transport vectors converge, which occurs near crater walls and topographic features in the crater interior. Dune fields also only form with a high sediment supply, which occurs and locations where extrabasinal sand enters the crater. Asymmetric barchanoids, the most abundant dune type, reflect the presence of two wind directions. The asymmetric barchans change orientation across a few grid cells where transport directions are variable. Dune fields are observed downwind of sand sheets, in areas with unidirectional transport and denote and increase in sediment supply and availability. Smaller interior sub-craters tend to divert transport vectors (Fig. 3) and form areas with continuous sand cover and complex dune types such as network dunes. Drifts were typically the result sand accumulating behind topographic features. Sand streaks were observed within unobstructed sand sheet areas. Linear and transverse dunes can be seen on the exterior edge of some barchanoid dune fields. Dome dunes were found at the downwind termination of the barchanoid dune fields. Coarse ripples were exposed in areas of diminished sediment supply.

The assessment of features across Herschel crater indicates crater topography and sediment supply are primary boundary conditions controlling the formation of aeolian features. Topography steers winds that drive flux divergence that gives rise to sand accumulation. Sediment supply appears extrabasinal and where it enters the crater basin controls the presence of aeolian features.

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References: [1] Malin & Edgett (2000), Science 88.5475: 2330-2335; [2] Roback et al. (2020), Icarus, 42:113642; [3] Grotzinger et al. (2005), EPSL 40.1:11-72; [4] Banham et al. (2018), Sedimentology 5.4:993-1042 [5] Cardinale et al. (2016), Icarus, 265:139-148; [6] Dickson et al. (2018), LPSC abstract 480.

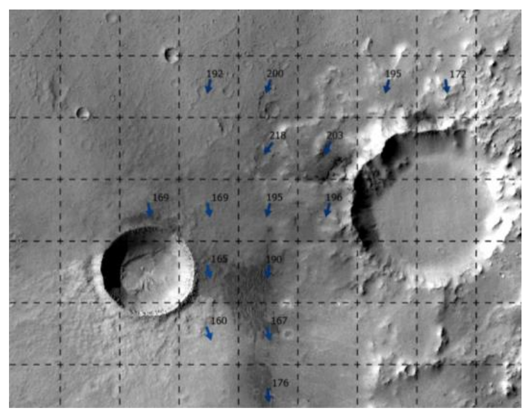

Figure 3. Bearing vectors overlain on CTX imagery, showing topography steered transportation shift. Dune field appears as darker toned material.