

GULLIES AS A SOURCE OF AEOLIAN SAND IN THE SOUTHERN MIDLATITUDES. L. K. Fenton, Carl Sagan Center, NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035, lfenton@carlsagancenter.org.

Introduction: Although gullies are common features in the midlatitudes of Mars [e.g., 1-3], it is not yet clear how the sediments they mobilize contribute to the sedimentary processes that shape the martian landscape. Sand dunes are widely distributed across the southern highlands [e.g., 4], suggesting that at least one significant source of aeolian sand is/was present. This work investigates gullies as a potential source of aeolian materials, particularly the dark mafic sand that comprises the many dune fields in the southern midlatitudes of Mars.

Background: Aeolian sand sources are regions from which sand-size grains (0.625 μm – 2 mm) are created (or made available by erosion) and exposed to a wind regime strong enough to saltate the grains. On Earth, most such sand is formed by weathering and erosion of crustal rocks (mostly quartz and feldspar) [e.g., 5]. Most sand is formed and concentrated by moving water (thus its prevalence along beaches, riverbeds, and lakebeds) [5], but other major formation processes include erosion of old sandstones (some of which are themselves former dunes), glacial scour, chemical precipitation (forming carbonate or gypsum sands), and volcanic ash.

Establishing the source regions of martian sand is an integral part of understanding the sedimentary history of that planet. Sand sources on Mars are not as well understood as those on Earth, but they appear to consist of layered materials that are eroding away and exposing sand (among other materials) to the wind [e.g., 6-9]. The processes forming and exposing these materials are not well constrained, but it is possible that moving water has played a role in producing and mobilizing sand on Mars. In a study of dune fields in Noachis Terra, a region in the southern midlatitudes ranging from 0°-60° E, 30°-65° S, [8] concluded that the only identifiable aeolian sand source was gullies (see Figure 1), although it is possible that in the past other erosional processes (now defunct, or with exhausted source regions) have made sand available for transport by the wind. The presence of sand on gully deposits is supported by the discovery of springtime defrosting spots on gullies, which are most commonly observed on dunes (indeed, these defrosting spots may be diagnostic of sand) [10].

Method: Starting with the distribution of gullies in the southern hemisphere [2, 11], all identified gullies were compared with the positions of known dune fields [4]. Because many small dune fields were not identified in a global-scale study [4], MOC narrow

angle and THEMIS VIS images near each identified gully (or gully system) were inspected for dunes. In many cases, dunes and dune fields were not identified near the gullies, but accumulations of dark sand were present (e.g., Figure 2). Such accumulations were not included in the list of gullies near dune fields, although the presence of the dark sand does indicate some amount of local aeolian activity.

Results: Figure 3 shows the distribution of Heldmann et al.'s gullies. Gullies with nearby dunes are shown in yellow; all other gullies are shown in red. Of the 1037 gullies/gully systems identified in the southern hemisphere, 289 (28%) are located in the immediate vicinity of a dune field. Many dune fields (not shown) do not appear to be associated with gullies.

Discussion: To first order, it does not appear that locations with gullies necessarily correspond to locations with dune fields (although the examples of images including both are suggestive of this). However, the distribution of MOC images (which were used to identify gullies [2, 11]) is nonuniform over the martian surface. Crater walls were imaged less often than crater interiors, and it is on crater walls where gullies appear to be most concentrated. It is possible that with further coverage by CTX and HiRISE, a closer correspondence between gullies and dunes may be established.

In addition, aeolian sand is nearly ubiquitous in small quantities in many regions on Mars. It is possible that gullies are responsible for eroding much of this sand, but that the supply is not great enough (or perhaps the wind is not strong enough) in all places to produce sand dunes.

Dark dunes are present across much of the martian surface. Because they are more widespread than gullies, it is clear that gullies cannot be a major source of dune sand on a global scale. Although a correlation cannot be established with available data, it is likely that gullies provide at least a minor component of the sand that composes aeolian sand dunes in the southern midlatitudes.

References: [1] Malin, M. C. and Edgett, K. S. (2000) *Science*, 288, 2330-2335. [2] Heldmann J. L. et al. (2007) *Icarus*, 188, 324-344. [3] Balme, M. (2006) *JGR*, 111, E05001, doi:10.1029/2005JE002607. [4] Hayward, R. K. et al., *JGR* 112, doi:10.1029/2007JE002943, in press. [5] Pye, K. and Tsoar, H. (1990) *Aeolian Sand and Sand Dunes*, 396 pp. [6] Ruff, S. W. et al. (2001), *JGR*, 106(E10), 23,921-23,927. [7] Byrne and Murray (2002) [8] Fenton, L. K. (2005) *JGR*, 110, E11004, doi:10.1029/2005JE002436. [9] Fergason, R. L. et al. (2006), *JGR*, 111, E12004, doi:10.1029/2006JE002735. [10]

Bridges, N. et al. (2001), *LPSC XXXII*, Abst. #2126. [11] Heldmann, J. L. (2004), *Icarus* 168,

285-304.

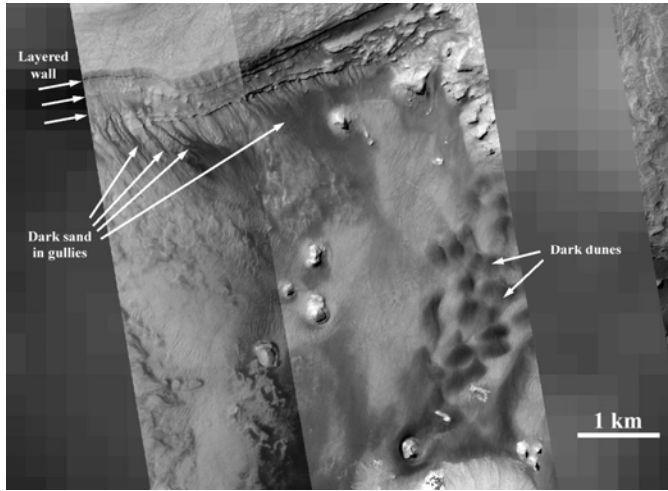


Figure 1. MOC images E11/00389 and R14/01181, showing gullies containing dark sand that likely contributes to aeolian sand dunes at the base of the cliff.

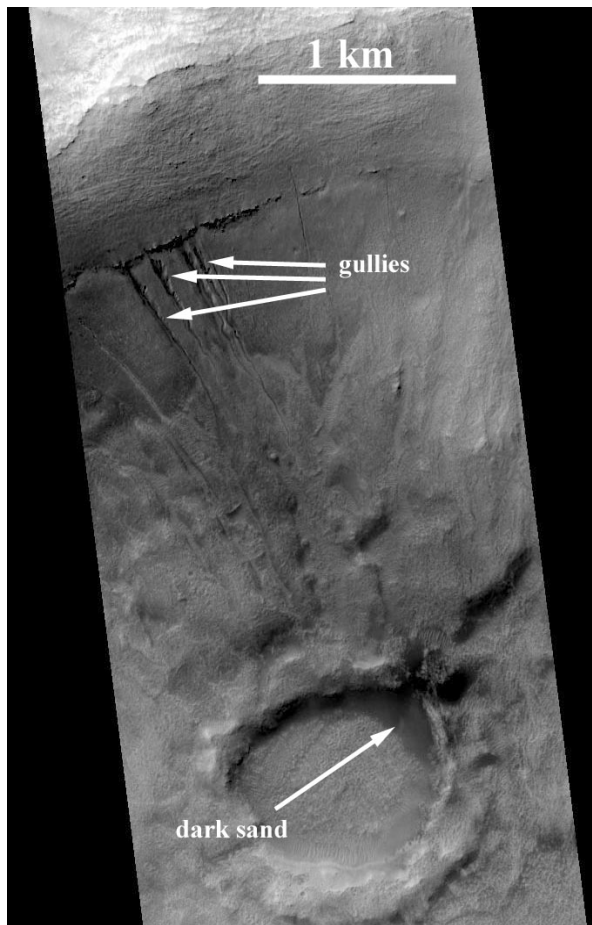


Figure 2. Gullies and dark sand (MOC image R16/01269). Even though no dunes are present, dark sand has still accumulated at the base of the cliff.

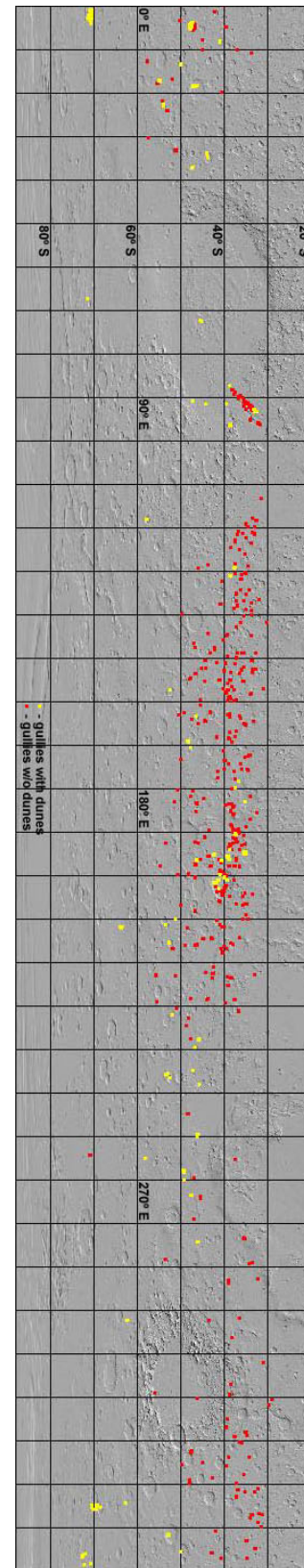


Figure 3. Distribution of gullies/gully systems in the southern hemisphere, showing those that may be associated with dune fields.