LOW ALBEDO SEDIMENT TRANSPORTED BY EOLIAN SUSPENSION ON MARS: WIND STREAKS IN WESTERN ARABIA TERRA.

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Summary: A single Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) image taken in October 1997 appears to solve a long-standing question about the origin and physical nature of the low-albedo wind streaks that emanate from impact craters in western Arabia Terra. The dark material is a mantle deposit, and these wind streaks appear to owe their origin to eolian suspension of low-albedo, fine-grained sediment deflated from the adjacent crater floors.

Background: Eolian processes involve erosion, transport, and deposition of particulate material. Grains that travel in suspension can form mantles—deposits of unconsolidated fine-grained material of locally uniform thickness that appear to drape all but the steepest topography. Materials that travel by saltation and traction can create bedforms (*e.g.,* dunes) or sand sheets. These features typically interact with topography, leading to morphologies distinctly different from mantles. The Mariner and Viking view of Mars holds that high-albedo regions such as Arabia and Tharsis are mantled by fine, bright dust, while low-albedo regions such as Syrtis Major are covered by dunes and/or sand sheets, and still other low-albedo regions had high rock abundance and were therefore assumed to have both sand and rocks (*e.g.,* Acidalia Planitia). MOC has shown that not all eolian bedforms have low albedos [1, 2], and that some low albedo regions (*e.g.,* Syrtis Major) are mantled [3]—both revolutionary results.

Dark Wind Streaks of Western Arabia: Some dark wind streaks on Mars are clearly associated with either eolian erosion or non-deposition of brighter material [4, 5], but one suite of dark wind streaks are considered to be different because they appear to be associated with the deflation of a dark intracrater deposit [4, 6]. These streaks are most prominent in western Arabia Terra; a few are also found in the Tartarus Colles/west Amazonis regions. They have been variously interpreted to consist of material deflated from the dark crater floor units [4, 6] or the result of eolian deflation via scour into the wind streak surface itself [*e.g.,* 7]. In either case, models for their formation assumed that they had to result from saltation and traction (because of the wind streaks' low albedo), although Thomas and Veverka [8] suggested the possibility of deposition from a plume of suspended particles. Thermal inertia derived from Viking infrared thermal mapper observations suggested that the wind streaks might consist of saltated sand [*e.g.,* 9].

MOC Image 3001 Observations: In October 1997, a MOC image was acquired that traverses from the floor, over the southern rim, and across a portion of a dark depositional wind streak associated with a 35-km diameter impact crater located at 4.2°N, 5.3°W (Figure 1). The ~4 m/pixel MOC image is shown at 6% of its original size in Figure 2. Four boxes, labeled A–D, indicate 2x2 km subsections of the image that illustrate the primary eolian features of this crater. Figure 2a shows a portion of the crater floor; this surface appears to have been deflated by wind, leaving remnant buttes, mesas, and pitted troughs. Figure 2b shows a portion of the crater floor at its contact with the south crater wall. The surface here is covered by a thick deposit of low albedo material that is expressed as small, dark dunes where the material lies adjacent to bright, rounded hills (interpreted to be yardangs). The arrow in Figure 2 indicates a patch of bright bedforms that occur in a crater that is otherwise buried by dark material. Figure 2c shows the surface outside the crater, immediately adjacent to the south crater rim. This surface occurs within the dark depositional wind streak. The surface is thickly mantled. Eolian bedforms are seen in this picture, and they are also mantled and therefore interpreted to be inactive. Figure 2d shows the wind streak surface about 15.5 km south of the crater rim. This surface, too, is thickly mantled. Like Figure 2c, the mantle covers older eolian bedforms that have crest orientations indicating winds that were nearly perpendicular to the wind regime inferred from the streak orientation. A MGS Mars Orbiter Laser Altimeter (MOLA) profile obtained on orbit 30 shows that the dark deposit on the south crater wall has a slope of about 33°.

Interpretations and Discussion: The crater floor at 4.2°N, 5.3°W is interpreted to include a material that has undergone eolian deflation. The deflated material included grains that could travel via saltation/traction and suspension. The coarsest material never left the crater floor, and forms megaripple-like bedforms. Finer, low-albedo sand was blown downwind and trapped by the south crater wall—the 33° slope indicates that this material is at the angle of repose. Sand attempting to migrate up this slope would be unlikely to attain the crater rim owing to slope instability. The dark material that has escaped the crater to form the wind streak is a mantle deposit, and it required deposition from suspension. The particle size of material in this mantle probably decreases southward (downwind)—this interpretation is supported by the Phobos 2 Termoskan image in Figure 1, that shows the dark crater floor material as bright (higher thermal inertia), and the wind streak as a bright feature that becomes darker and more diffuse downwind.

The observation of low-albedo mantles on Mars calls attention to some observations made prior to the MGS mission that suggested the possibility of fine-grained dark material (*e.g.,* photopolarimetric observations by Mars 5 suggesting the presence of low-albedo, silt-sized material in Mare Erythraeum [10], and a low-albedo dust storm seen by Viking Orbiter 1 in Terra Cimmeria [11]). Bright dust on Mars is typically thought to consist of grains smaller than 10 µm—and perhaps closer to 1 µm [12]; however it is clear from the eolian physics work of Iversen and White [13] that silt and perhaps even fine sand (*e.g.*, up to ~150 µm) can undergo at least short-term suspension on Mars [14]. MOC images of additional western Arabia Terra dark wind streaks taken during September 1997 to September 1998 support the notion that all of these streaks are mantle deposits [3]. The dark material comprising these wind streaks are most likely to consist mainly of silt and very fine sand.

References: [1] Malin M. C. et al. (1998) *Science, 279*,1681-1685. [2] Thomas P. et al. (1999) *Nature*, in press. [3] Edgett K. S. and Malin M. C. (1999) LPS XXX, this volume. [4] Thomas P. et al. (1981) *Icarus, 45*, 124-153. [5] Greeley R. et al. (1974) *Proc. R. Soc. Lond., A-341*, 331-360. [6] Arvidson R. E. (1974) *Icarus, 21*, 12-27. [7] Soderblom L. A. et al. (1978) *Icarus, 34,* 446-464. [8] Thomas P. and Veverka J. (1986) *Icarus, 66,* 39-55. [9] Peterfreund A. R. (1981) *Icarus, 45,* 447-467. [10] Dollfus A. et al. (1993) *JGR, 98,* 3413-3429. [11] McEwen A. S. (1992) *LPS XXIII,* 877-878. [12] Toon O. B. et al. (1977) *Icarus, 30,* 663-696. [13] Iversen J. D. and White B. R. (1982) *Sedimentology*, *29,* 111-119. [14] Edgett K. S. and Christensen P. R. (1994) *JGR, 99,* 1997-2018

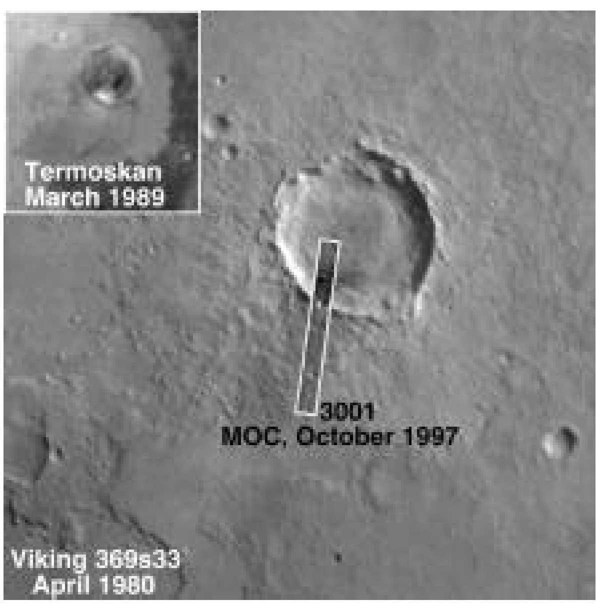

Figure 1. Location of MGS MOC image in crater centered at 4.2°N, 5.3°W. Termoskan image is from Phobos 2. North is up, the Viking image is illuminated from the right; the crater diameter is 35 km.

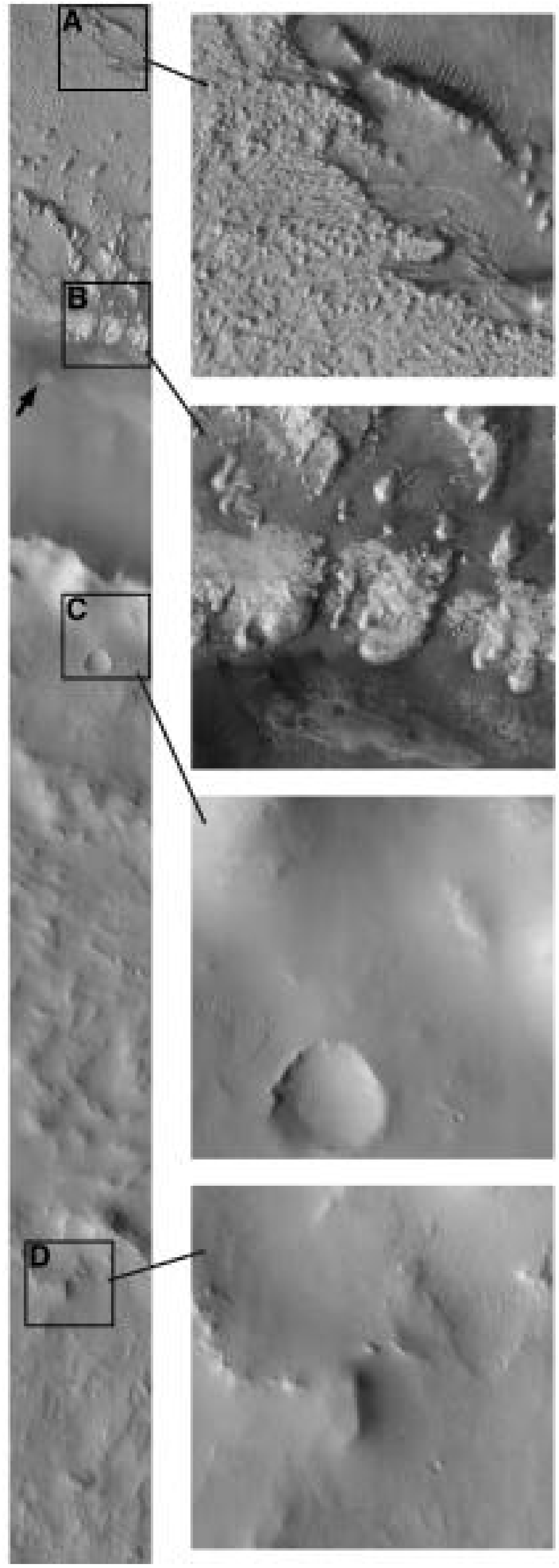

Figure 2. MOC image 3001. Each box is 2x2 km. Illumination is from the lower left, north is approximately up. See text for description.