Dust Devil Tracks on Mars: Observation and Analysis from Orbit and the Surface

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Introduction: Dust devils result from active processes on Mars that redistribute particles, changing the surface and atmosphere. Dust devils commonly develop where strong heating of the surface forms a layer of super heated air just above the ground (1,2). Long narrow dark streaks seen on *Viking Orbiter* images of Mars were suggested to be the tracks from vortical atmospheric activity (3). This was confirmed by orbital observations of active vortices leaving the tracks (4), and these albedo features are now generally recognized to be tracks from the passage of dust devils (4). The *Mars Exploration Rover Spirit* landed in *Gusev Crater* on January 3, 2004, in an area where dust devil tracks are common. *Spirit* traversed a recently formed dust devil track. The objective of this study was to observe a dust devil track seen from orbit and analyze the track on the ground with *Spirit* data.

Approach: Spirit's Microscopic Imager (MI) made observations inside the dust devil track, on the contact of the dust devil track and the plains, and outside of the dust devil track. Experiments were also conducted utilizing the Arizona State University Vortex Generator (ASUVG), a facility used to simulate dust devils (5). The effects of dust devils over similar size particles were studied in the laboratory, and the results were compared with the features in *Gusev Crater*.

Results: Figure 1 is a view toward the landing site from the rim of *Bonneville Crater* taken on Sol 66, showing the dust devil track *Spirit* drove over. This track is visible as a relatively lower albedo streak through the middle of the image. *Spirit* crossed over the track and entered the relatively higher albedo terrain on approximately Sol 52.

MI images of the crests of bedforms were taken inside the dust devil track on Sol 39 (Figure 2.), on the contact of the dust devil track and the plains on Sol 52 (Figure 3.), and outside of the dust devil track on Sol 73 (Figure 4.) These bedforms have approximately the same distribution of large, rounded, spherical sand grains with varying amounts of dust and finer particles.

Larger particles in the bedforms are ~800 to ~1800 microns, while dust and fine grain sand particles are less than ~180 microns. Smaller particles are least abundant in the Sol 39 MI (inside the track), intermediately abundant in the Sol 52 MI (on the contact of the track and the plains), and most abundant in the Sol 73 MI (outside of the track); supporting the hypothesis that dust devils can remove dust and fine grains from the surface.

The ASUVG experiments consisted of light colored pumice particles with a mean particle size of ~1700 microns sieved on to the test bed, and then darker basaltic ash with a mean particle size of ~150 microns sieved on top of the pumice. This was then moved underneath the vortex to simulate dust devil surface interaction. The dust devil was able to remove dust and fine grains while leaving behind cleaned larger grains, therefore forming a linear streak that retained the relative albedo of the underlying layer once covered by fine particles.

Summary and conclusions: Long narrow dark streaks seen on Viking Orbiter images of Mars suggested to be tracks from vortical atmospheric activity (3), are now generally recognized to be tracks from the passage of dust devils (4). The theory that dust devils form these relative albedo differences by removing dust from the surface to expose a darker substrate (6), has been confirmed as a result of this study.

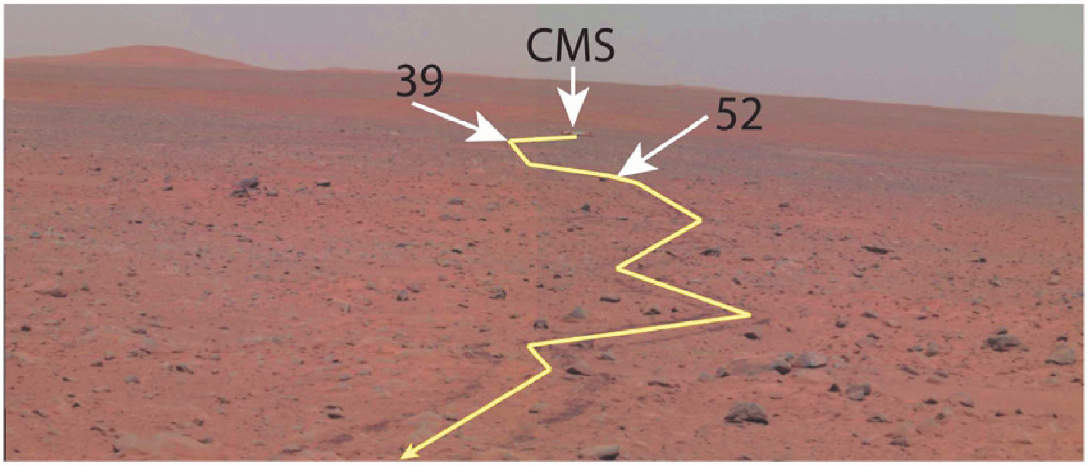

Figure 1. Spirit looking back on its traverse (yellow line) from atop the rim of *Bonneville Crater* reveals relatively different higher and lower albedo features. The dark streak in the center of image is the recent dust devil track. CMS (*Columbia Memorial Station*) indicates *Spirit's* landing site. Sol 52 is on the contact of the dust devil track. NASA/JPL/Cornell.

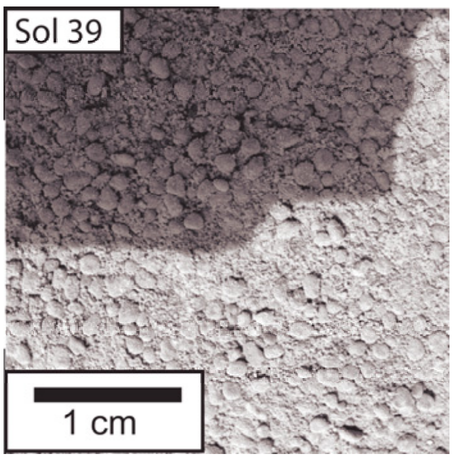

Figure 2. Dust and fine grains are less abundant where a recent dust devil has traversed over on Sol 39. NASA/JPL/Cornell/USGS

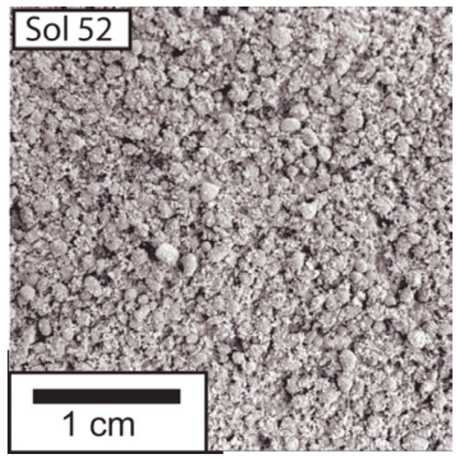

Figure 3. Dust and fine grains are more abundant on the contact of the dust devil track on Sol 52. NASA/JPL/Cornell/USGS

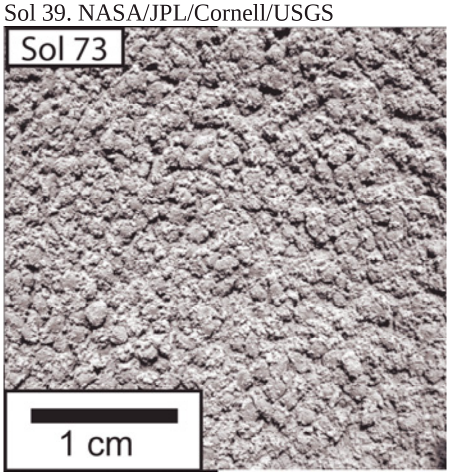

Figure 4. Dust and fine grains are most abundant on Sol 73 outside of a dust devil. NNASA/JPL/Cornell/USGS

References: 1] Hallet and Hoffer, 1971. 2**]** Sinclair, 1976. 3**]** Grant & Shultz, (1987) Science, v. 237, 883-885. 4**]** Edgett K.S. & Malin M.C., (2000) JGR, 105, 1623. 5] Greeley et al., (2003) JGR, 108, 5041**.** 6] Greeley et al., (2003) JGR, 108, 8077**.**