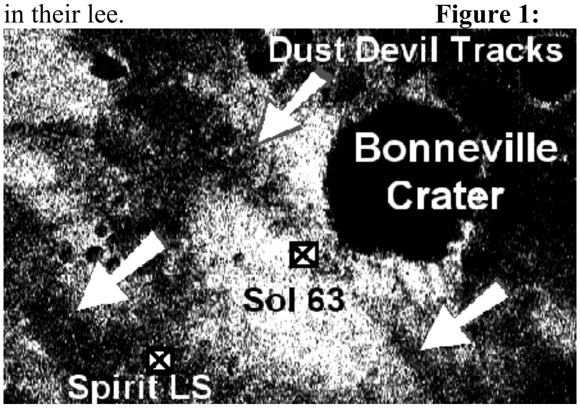
EVIDENCE OF DUST DEVIL SCOUR AT THE MER SPIRIT GUSEV SITE. S.M. Metzger: Metzger Geoscience, 2875F Northtowne Ln, #165, Reno, NV 89512-2058, <dustdvl1@yahoo.com> www.dustdevils.org

Introduction: Using MOC orbital images and several image sets from MER Spirit (Pancam, Navcam and MI), it has now become possible to study at substantially different scales the effects of dust devil vortices as they pass over the surface of the planet Mars. Prior to the January 2004, landing of the Mars Exploration Rover *Spirit* in Gusev crater, MOC images indicated a number of dust devil tracks in the immediate area. This report will make the case for (1) a limited number of days when vortex formation could proceed, (2) dust devil scour evidence on a rock examined by the Microscopic Imager (MI), and (3) calculate dust removal rates during one season in Gusev.

Gusev Dust Devil Tracks: MOC image R07-01606-04 covers 2.95 x 12.06 km at 1.44 m/pxl and includes the Spirit landing site atop numerous dust devil tracks. The central track cluster has too many overlapping trails to count. Along the cluster perimeter and North of Spirit's landing site are at least two distinct families of track orientations (NW >> SE, and W >> E). There are two prominent size clusters (many small/medium, and a few huge [=250m max.]). Thus, this portion of the Gusev dust devil track field may represent a mere two days of activity. If so, one of those days spawned a few big vortices among the common mid-sized batch. The other day spawned more numerous but more restrained diameter vortices, apparently immediately following eachother off the trigger points (as offset parallel tracks, similar to foreset bedding where bounding conditions remain stable while an intermediate condition, in this case *wind*, gently & progressively shifts). Windward crater rims clearly provide trigger points, producing track swarms in their lee.

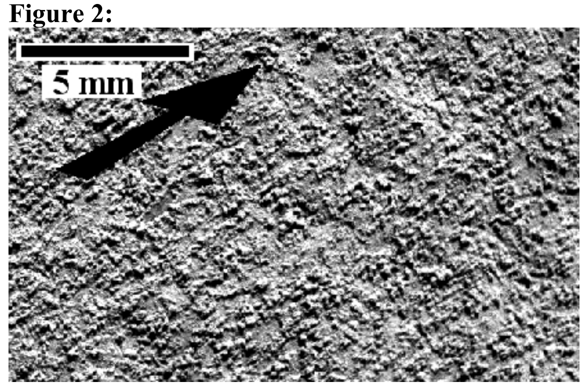
Figure 1:



From Sols 45 to 65, Spirit headed NE directly toward Bonneville crater. The first figure shows a 50m-wide DD track, immediately downslope from the crater rim, which crosses that Bonneville trek with an orientation from NW to SE. The Sol 63 scrutiny of "Plank" rock occurred along the southern boundary of this track. MOC image R07-01606-04 was acquired several months prior to Spirit's arrival. In the MOC images taken shortly before landing, this track is not apparent, presumably having been re-covered by the ubiquitous airfall of fresh dust.

Dust Devil Scour: On Sol 63, Spirit used the MI to examine Plank. That image (2M131952663EFF13-00P2957M2M1) reveals a striated pattern of near-parallel microgrooves with a lower left – upper right orientation, seemingly etched or burrowed into the rock's dust drape (fig. 2). The dust drape has a clumpy texture whereas the microgrooves seem to have extended to the rock surface, which appears smooth and flat. Microgroove orientation is roughly parallel to the rover's path toward Bonneville crater and thus perpendicular to the dust devil track.

Figure 2:



The Pancam (2P131956762ESF1300P2530L-3M1) and Navcam (2N131869552EFF12BOP193-3L0M1) images of Plank reveal several aeolian features (fig. 3). The rock itself, as with most rocks in the vacinity, appears to be a well developed ventifact whose faces are consistent with the wind directions that left the dust devil tracks (NW-SE). Minor rock wind tails around Plank indicate formation under a NW-SE flow pattern. Small deflation moats encompass most rocks, including Plank. Pancam resolved dark, coarse sand-sized grains along Plank's moat.

The microgrooves on Plank rock are interpreted to be impact trenches from saltating sand carried in the base of the vortex that created the dust devil track. The sand grains (or sand-sized aggregates) are presumably the same as those seen in the moat around Plank's perimeter. Similar grains, believed to be basaltic clasts, were imaged by the MI on Sol 39 at the beginning of Spirit's trek (close to the landing structure) (fig. 4). Their well rounded shape and well sorted size range is likely the result of prolonged aeolian transport. The near-lack of dust drape in the Sol 39 MI image is consistent with a locally darker albedo which, in turn, is consistent with a different dust devil track at the landing site. This report concludes that Spirit left a fresh track then drove across a partially obscured track to Bonneville crater. **Figure 3:**

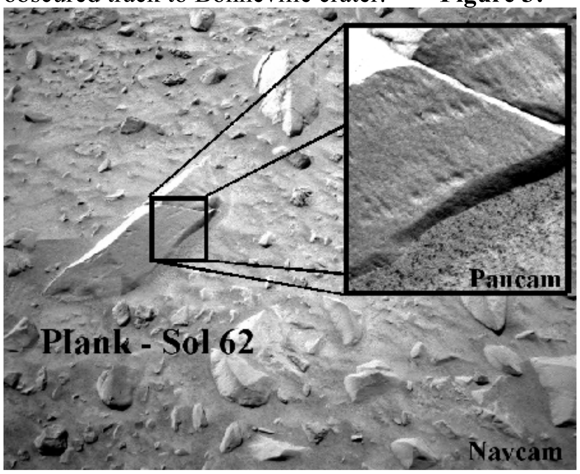
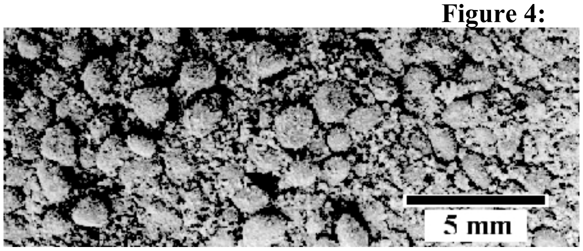
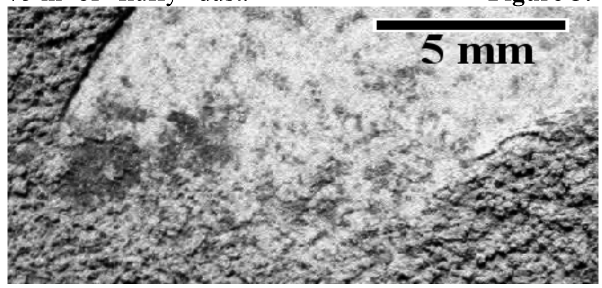


Figure 4:



Given a vortex scour origin for the striations, several aspects of that process can be examined further. Based on terrestrial field studies of natural dust devil wind fields [1], desert vortices are usually strongest on the trailing edge of the column. Regardless, surficial evidence from the trailing edge has the greater preservation potential. Also, given that the microgrooves are essentially parallel, it is interpreted that they represent the "lift-off" portion of their entrainment in the wind, not their chaotic return to the surface. Thus, this particular dust devil was rotating in a clockwise direction, although this is probably a moot point. Numerous dust devil researchers have demonstrated that natural thermally driven vortices do not consistently follow either rotation. [2] report that dust devil rotation is strongly influenced by site-specific eddies that form in the lee of upwind obstacles.

Dust Removal: Assuming that the Sol 63 track's dust devil was typical (a suggestion supported by a width similar to other tracks imaged in this region of Gusev), the extent of dust removal can be assessed. Using visual estimation methods, approximately 50% of the Plank surface has been scoured clear of its dust drape. The thickness of the remaining dust deposit is roughly 100 microns. Given a 50 m wide, 3 km long track with 50% removal of a 100 micron dust layer, this modest feature represents the airborne injection of 75 m^3 of "fluffy" dust. **Figure 5:**



MOC images indicate releatively few dust devils have crossed Gusev (perhaps only 10% of the basin experienced erosive vortices) (fig. 5 – Sol 65 at the rim of Bonneville crater, MI #2M132132632EFF1500-P2958M2M1). Furthermore, tracks within the effected regions still only account for 5 to 50% of the total surface. Yet, there are several thousand tracks in Gusev and many are larger that the one examined on Sol 63. Therefore, during a single, brief dust devil season as recorded by albedo changes in Gusev, substantial tonnage of this unconsolidated, uncompressed "fluff" was resuspended into the atmosphere. "Fluff" simulation under laboratory conditions is required before calculating the mass of such a volume of what is described here as a gently-deposited fine particulate.

Conclusions: The tracks suggest that even in an area seen from orbit to have been crossed by dust devil tracks, vortex production actually is rather low. The few MOC frames that do indicate tracks in the immediate area also indicate that those tracks generally formed at some elevated prominence (i.e. an upwind crater rim), usually in sets. Most MOC frames of the area have little or no sign of tracks. Spirit's Pancam and Navcam images reveal a broad surface covered by fewer large rocks (except on the upper slopes of larger craters) than seen at the MPF Ares Vallis landing site (which experienced thermal vortices every 2 days). Thus, if the surface aerodynamic roughness doesn't cross a sufficient threshold, vortices only form under perfect meteorological conditions at key topographic trigger points. On those nexus days, patches of the basin floor would be sprouting dozens of dust devils, often with several active at once. When that occurs, the thermal vortex process resuspends large quantities of fine particulates back into the dust transport system.

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References: [1] Metzger *et al*., 2004, GSA Ann. Mtg. Abs w/ Prog, #5-11 [2] Metzger et al., 2004, EOS Trans. AGU Fall Mtg Abs P14A-08.