DUST "DRIFTS" ON MARS. P. E. Geissler[1], L. K. Fenton[2], N. T. Bridges[3] and the HiRISE Team, [1]Center for Astrogeology, U.S. Geological Survey, Flagstaff, AZ 86001 USA (pgeissler@usgs.gov); [2]NASA Ames/SETI Institute, Mountain View, CA 94043 USA; [3]APL, Laurel, MD 20723 USA.

Introduction: Eolian sedimentary deposits are important because they provide a record of the direction and strength of winds on Mars and the type and flux of sediments transported by the winds. While Martian sand dunes and transverse aeolian ridges ("TARs") have been thoroughly studied, the sedimentary deposits left behind by blowing dust have received comparatively little attention to date. With the unprecedented resolution of the HiRISE camera on Mars Reconnaissance Orbiter, we can study surface features too small to have been seen in orbital observations by previous missions. In a few locations, features have been spotted that are interpreted to be dust "drifts", representing a new class of Martian eolian deposits distinct from dunes and TARs.

Dust drifts on the giant volcanoes: Bright tapered deposits were first noticed in a HiRISE image of the west flank of Alba Mons in late 2007. In a whimsical caption written just after Christmas [1], the HiRISE team pointed out that the dust here appears to be temporarily trapped in the lee of crater rims, both inside the craters and along the outside rims where they form streamers that resemble St. Nick's beard (Figure 1).

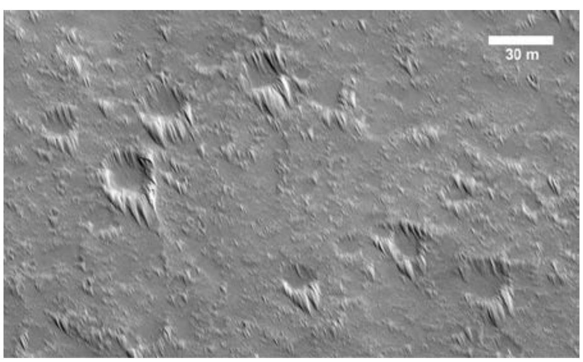

Figure 1. "Santa Claus" craters on the west flank of Alba Mons, so named because of the "whiskers" that line the downwind crater rims. HiRISE image PSP_006271_2210, shown here with north towards the bottom.

Similar features have since been found in HiRISE images of the south flank of Arsia Mons, and near the summit of faraway Elysium Mons (Figure 2). All of these are in high elevation, dust covered regions. Each of these locations shows tapering dust deposits in the lee of crater rims and other topographic obstacles. The dust deposits fill in depressions (including crater interiors) and extend outside of the craters in long streamers that drape the downwind rims. The deposits do not occupy the smooth crater floors, suggesting that topography is needed for their formation.

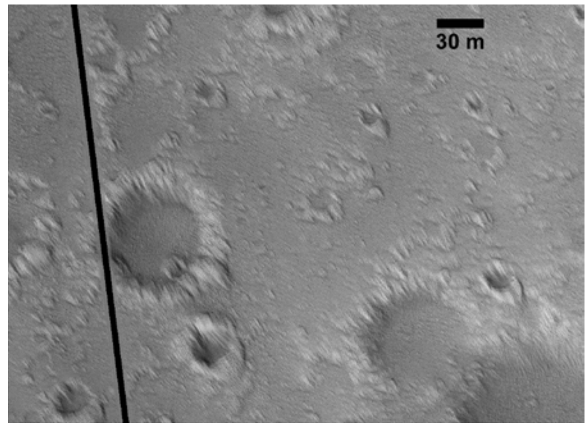

Figure 2. Dust drifts south of Elysium Mons caldera. PSP_004547_2050.

Dust drifts in Syria Planum: The detailed interpretation of these deposits was not called into question until similar features were found in a region that is largely devoid of dust. As part of an earlier study of surface albedo changes [2], we examined many HiRISE images of Solis Lacus, an area that we had identified in low-resolution global images as the most rapidly changing region on Mars. HiRISE images of Solis show mostly rocky surfaces with thin, transient covers of dust that are frequently swept away by winds and dust devils. However, in the northwest of the region (Syria Planum) are found stable dust deposits that are upwind and uphill of Solis and may act as a source of the dust responsible for the frequent albedo changes.

More interesting still are the dust deposits downwind of these patches. Figure 3 shows cutouts from ESP_014406_1670 in Syria Planum, showing features that bear a striking resemblance to the "whiskers" of Alba Mons. Bright deposits trail downwind (south) from crater rims in tapering deposits. These deposits are not seen on the smooth crater floors, but only where topographic obstacles occur at the rims. Dust has also accumulated behind boulders (Figure 3B) in similar tapering deposits. Many of the deposits are long and narrow in comparison to the sheltering obstacles and several are notably sinuous in planform, having up to three inflexions. These deposits are particularly conspicuous against the dark, dust scoured substrate.

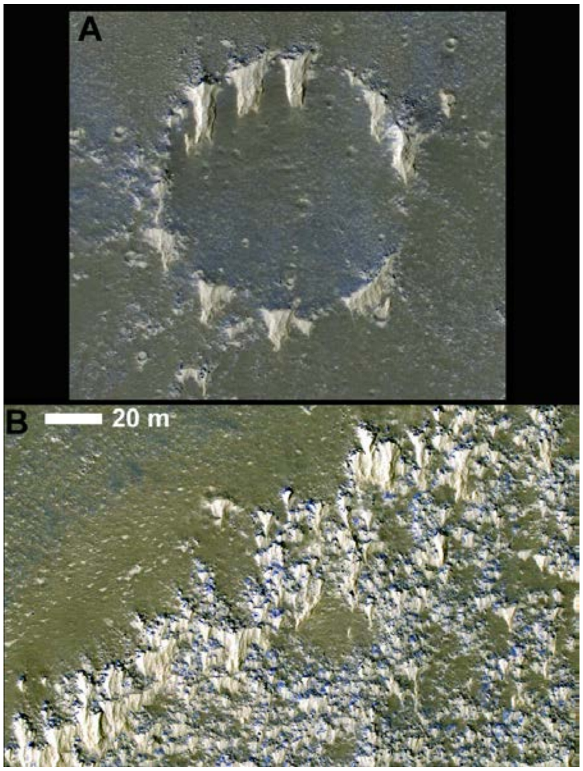

Figure 3. Tapering bright deposits in Syria Planum. Note the sinuous planforms and narrow aspect ratios (A) and association with topographic obstacles, rocks that appear blue in this false color image (B). ESP_014406_1670.

A nearby area where similar features were observed is located to the southeast, farther downwind from the extensive dust deposits to the north. PSP_010028_1630 shows tapering bright deposits trending towards the southeast, similar to the trends of nearby wind streaks. Here we see small streaks emanating from the bright deposits, suggesting that the deposits may be made up of unconsolidated dust. Undulations can be seen in the thick dust deposits that are clearly not laminar. The deposits are thick enough here to be measured by the length of their shadows. These measurements indicate that the bright deposits stand at least 70 cm above the surface.

Interpretation: At first sight, we interpreted these deposits as erosional features, remnants of a formerly extensive layer of dust that was at least 70 cm thick. However, several details of the morphology and situation of the deposits fit poorly with that explanation. Erosional remnants such as “yardangs” are well known from terrestrial experience and are distinctly dissimilar to the tapered bright deposits in several respects. Yardangs can be much taller than the particle saltation height and seldom form in the lee of topographic obstacles but rather assume the shape of an inverted boat hull: symmetric, straight, and aerodynamic [3]. Taller ventifacts can be undercut by abrasion at the saltation height. Laminar layering is often exhibited by yardangs, unlike the undulations noted previously. Yardangs on Mars tend to be preserved in topographic lows such as crater floors [4], where they are less susceptible to erosion. This is opposite to the situation of the dust “drifts”.

Even if they are not resistant yardangs, could the tapered deposits be unconsolidated sediments that have resisted erosion by sheltering in the lee of topographic obstacles? The shapes and aspect ratios of the deposits argue against this notion. The deposits are long and narrow in comparison to the size of the sheltering obstacle. The deposits are also sinuous in plan, often having up to three inflexions. Long and narrow deposits could be left in the lee of an obstacle in the case of erosion by winds from a constant direction, but sinuous deposits would require multiple wind directions. In that case, the angle between the wind directions would limit the distance from the obstacle to which sheltering would be effective, and shorten the length of the deposits. Erosional “wind tails” found on Earth and Mars rarely reach more than a few tens of cm in length [5]. In contrast, the tapering dust deposits in Syria Planum and on Alba Mons trail up to 20 m behind topographic obstacles that are typically much smaller.

We suggest instead that the tapered deposits are dust drifts, accumulated during periods of strong surface winds that were heavily laden by dust. We know from the MER rovers that dust is swept across the surface during global dust storms, accumulating on the robots and contaminating the optics of the instruments (even those protected by dust covers!). We suggest that horizontal dust transportation can in places build sedimentary structures that are an entirely new class of eolian deposit, distinct from dunes and TARs. Dust is caught up by topographic obstacles and sticks to the surface, piling up on the downwind rims of the craters and partially infilling the upwind sides. Between dust storms, the features must undergo erosion, so they may currently be in an erosional state in spite of the fact that they were formed by dust deposition. If this interpretation is correct, the deposits offer the possibility of tracking the direction of horizontal dust transportation wherever these features are found.

References: [1] http://hirise.lpl.arizona.edu/ diafotizo.php?ID=PSP_006271_2210 [2] Geissler et al. LPSC 2012 [3] Ward , JGR 84, 1979 [4] e.g., MGS MOC Release No. MOC2-1283, 16 Nov 2005 [5] Greeley et al., JGR 107, 2002.