FIRST IN-SITU INVESTIGATION OF A DARK WIND STREAK ON MARS.
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Introduction: Wind streaks are among the most distinctive of Martian aeolian features, and their directions and changes have been used to monitor winds on Mars since the earliest spacecraft explorations [1-10]. Bright streaks are commonly caused by the deposition of bright dust, but the origin of dark streaks has been more problematic. Various scenarios have been proposed to explain the giant dark streaks that decorate Meridiani Planum and Oxia Palus, either by deposition of dark sediments or by erosion of bright dust that leaves behind a dark lag or exposes a darker substrate. Prominent dark streaks issue from embayments at the north end of the Victoria Crater in Meridiani Planum, the site of surface investigations by the MER rover Opportunity (Figure 1). Opportunity was sent to examine the darkest of these streaks and compare it to the adjacent soil in the bright corridor between the streaks.

Figure 1: Victoria Crater and its dark wind streaks.

Approach: Opportunity's investigations were aimed at testing several competing hypotheses for the origin of the dark streaks: (1) erosion of bright dust, revealing a darker substrate, was deemed unlikely because the bedrock exposed in the crater rim and ejecta blanket is brighter than the surrounding soil; (2) erosion of bright dust, leaving a lag of dark sand or hematite-rich spherules, was expected to produce a greater abundance of spherules and rock fragments inside the streak than on the adjacent plains outside of the streak; (3) deposition of dark silt, carried by the winds in suspension, was expected to darken the surface without affecting the abundance of larger soil components or altering the surface morphology; (4) deposition of dark sand, carried by saltation or traction, was expected to leave deposits in dunes and drifts; (5) deposition of dark spherules, rolled along by the wind in traction, was expected to produce an increase in the abundance of spherules, similar to (2).

Two nearby sites inside and outside of the streak were selected for visible and infrared remote sensing by Pancam and Mini-TES and for APXS elemental abundance measurements and MI images of the microscopic soil morphology. Based on these observations, the rover would then be sent to study features diagnostic of the source of the streak.

Results: Microscopic images (Figure 1) within the wind streak showed unconsolidated sand deposits that were deep enough to darken the surface by burying bright millimeter-sized lithic fragments, presumably ejecta from the interior of the crater.

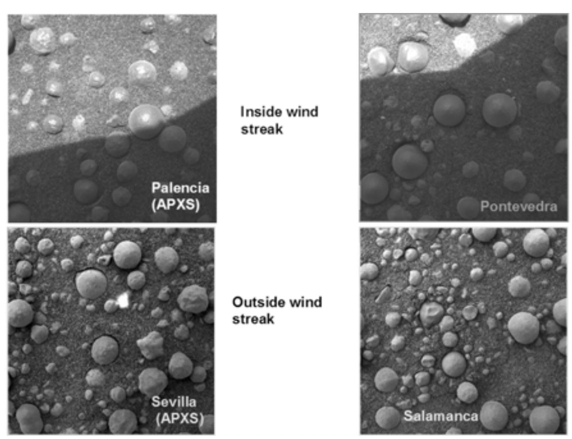

Figure 1: MI images (3 cm across) of streak soils

Elemental abundances from APXS showed a reduction in S and Cl inside the streak, consistent with a reduction in dust abundance. Photometric measurements made by Pancam at various times of day showed that the streak was markedly less back-scattering than the surrounding terrain. Mini-TES measurements showed that the thermal inertia inside the streak was greater than that of the neighboring plains, indicating coarser grained sediments. Color images of the rover's tracks showed that it is easier to push blueberries into the soft dust outside the wind streak than into the coarser sand inside the streak (Figure 2).

Figure 2. Wheel tracks outside (left) and inside (right) of the wind streak.

Opportunity was next driven to an obstacle close to the source of the streak, an angular block ~25 cm across. In the lee of the block was found a small sand deposit deep enough to bury spherules up to 5 mm in diameter. This patch of sand, nicknamed Alicante, eroded and disappeared over the few days Opportunity examined it (Figure 3). Mössbauer measurements of the disappearing deposit showed a composition of hematite, olivine and pyroxene with very little nanophase oxides present, consistent with a mixture of relatively clean basaltic sand and hematite spherules.

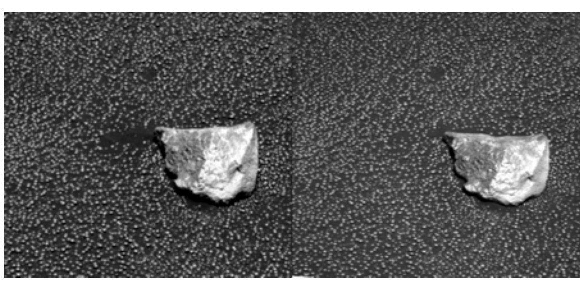

Figure 3: Alicante, sols 1143 (left) and 1150 (right).

Discussion: Opportunity's observations suggest that the Victoria wind streaks are deposits of basaltic sand blown out of the crater from the dark dunes nestled below the crater rim. No local sources of sand have been identified within the Victoria Crater wall rock, suggesting that the sand must be transported into the crater from the surrounding plains. This process presents a possible explanation for the serrated margin of Victoria Crater, through abrasion of the soft rock as temporarily trapped sands are blown out of the crater and carve alcoves under various seasonal winds. Estimates of the amount of erosion that has taken place can be made from the size of the crater and the scale of the embayments [11]. Some constraints on the rate of activity of these wind streaks, and hence the age of the crater, will be provided by continued monitoring of the erasure of the rover's tracks by MRO HiRISE [12].

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