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# Variable scale surface change of Valles Marineris dune fields and adjacent terrains

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## Abstract

The Valles Marineris (VM) has a large population of dune fields [2] and excellent orbital image data coverage, making it an ideal region to assess active aeolian modification. Here, we present evidence from multiple orbital sensors for surface changes in VM dune fields and adjacent terrains at multiple temporal and spatial scales.

## 1. Data and Methods

This study utilized MOC-NA [6] and HiRISE [7] visible-wavelength images, collectively acquired from 1997 to the present, to search for evidence of surface changes. All images were radiometrically calibrated, and spatially registered to fixed, static tie points (*e.g.*, craters) using ArcGIS software and the method of [3]. We also employed three Mars years of TES bolometric albedo data [4, 8], to search for changes in surface albedo.

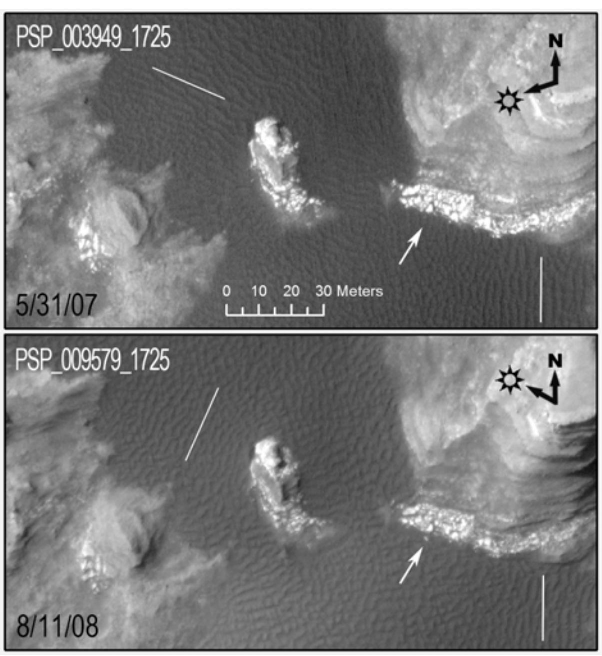


Figure 1: Ius Chasma surface change (white arrows) and changes in megaripple alignment (left, white bars). Note the change in solar azimuth.

## 2. Results

### 2.1 HiRISE-HiRISE: Megaripple Modification

Repeat HiRISE images offer the opportunity for meter-scale change detection. Figure 1 shows surface change associated in Ius Chasma. Dark megripples show local realignment (top left bar in the two images), in some cases by as much as ~90°, over the course of two Martian seasons. Other megaripples show no change in alignment (bottom right). Additional exposures of light-toned rocks show evidence for sand movement (white arrows in Figure 1 and adjacent areas not shown). Aeolian reworking, either by saltation or creep, seems the only plausible scenario. This occurrence is similar in scale and time frame to that observed on ripples in Nili Patera [9].

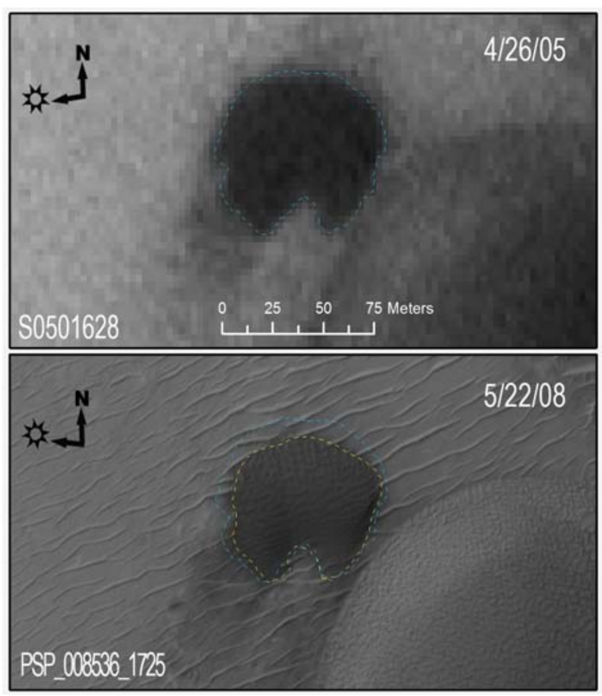


Figure 2: Evidence for a Ganges Chasma sand dune deflating from 2005 (blue) to 2008 (yellow). For the two images, we estimate the minimum threshold value for detectability is ~7% (see [3] for technique).

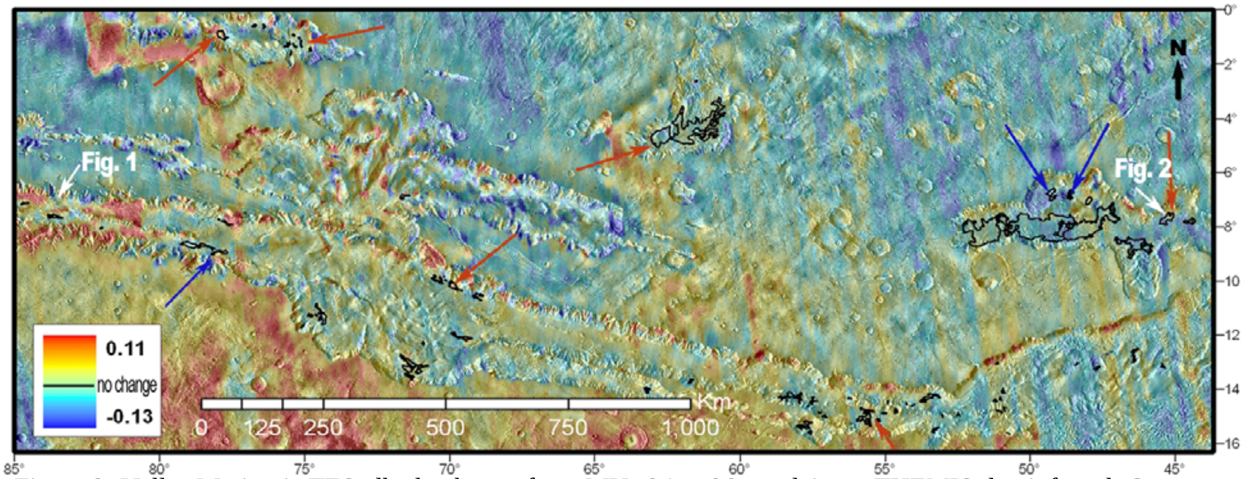


Figure 3: Valles Marineris TES albedo change from MYs 24 to 26 overlain on THEMIS day infrared. Compare with [8]. Dune field are shown in black. Red and blue arrows indicate dune fields with substantial albedo changes. Mars years relative to Earths years are: MY 24: 7/1998-5/2000, MY 25: 6/2000-4/2002, MY 26: 5/2002-3/2004.

### 2.2 MOC-HiRISE: Dune Deflation

Our conservative estimates suggest one small eastern Ganges Chasma barchan dune shows a ~20% decrease in area over the 1.6 Mars year hiatus between images (Figure 2). We interpret this as putative evidence for aeolian removal comparable to dune deflation observed in the North Polar erg [1] and Endeavour crater [3]. The dune's location on the inferred upwind perimeter of the dune field may make it more susceptible to changes [3].

### 2.3 TES: Albedo Changes

Figure 3 shows change in TES albedo from Mars Year (MY) 24 to MY 26 in VM. Many intra- and extra-chasm locations show notable darkening (blue) and brightening (red) over the three Mars years of data coverage. These locations show similar albedo changes across several orbital tracks (arguing against instrumental or atmospheric causes) encompassing 100's to 10,000's of $km^2$ of area. Typically dune fields get darker from MY 24 to 25 (*e.g.*, from 0.13 to 0.11), and then get brighter from MY 25 to 26 (*e.g.*, from 0.11 to 0.14), and the largest albedo changes were up to 35%. These trends were not observed for many adjacent terrains or for the global dataset, suggesting they were not the result of systematic instrument error. We attribute these trends to dust removal and deposition events, respectively. This time frame of "brightening" coincides with the 2001 global dust storm. Additionally, the most common evidence for dune change in visible-wavelength images comes with active dust devils and their tracks, corroborating the notion for dust lifting or removal events. Alternately, sand may be put into suspension from impacts with salting sand grains due to wind shear forces.

## 3. Discussion

Sand dunes on Mars tend to concentrate in topographic lows, such as craters, polar basins, and the VM rift system. Contemporary dune activity in two other locations on Mars has been previously documented [1,3,5,9]. Evidence presented herein suggests surface changes in a third region. Moreover, our findings show VM dunes and adjacent areas are actively changing at a number of scales (*e.g.*, megaripple modification, dune deflation, and dune field albedo change) that correspond to data resolutions. Contemporary dune changes may be found globally through additional detailed temporal comparisons using high-resolution data.

## References

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