

THE DEGRADATION OF OPPORTUNITY'S ROVER TRACKS - A PROXY FOR LOCAL AEOLIAN ACTIVITY ON MARS. J. M. Widmer¹ and M. Day¹, ¹University of California, Los Angeles (jacob.m.widmer@gmail.com)

Introduction: Present-day geomorphological activity on Mars is dominated by wind and ice [1]. Our understanding of this activity has increased dramatically over the past two decades but a scarcity of in-situ instruments have made it difficult to obtain datasets for wind regimes [2]. Therefore, martian wind regimes are often studied from orbit by observing various surface morphologies that result from aeolian (wind-driven) activity [3-5]

In addition to orbital imaging, several generations of Mars rovers have provided invaluable insight into aeolian activity with high-resolution images over small geographical areas and the ability to explore different terrain types [6-9]. As these rovers move about the surface, they leave physical impressions or “tracks” in their wake. In 2010, previous work [10] investigated tracks left by Mars Exploration Rover Spirit (MER-A) and Opportunity (MER-B) during the first 2000 sols of the MER mission. They estimated the timescale of track erasure was ~1 Mars Year and influenced by a mixture of gradual and episodic sediment transport events [10].

In this study, we use the degradation of tracks left by the Opportunity rover as a tool to monitor aeolian activity over 14 Earth years. We build on previous work [10] by investigating new locations of Opportunity's tracks over a longer timescale to quantify sediment transport rates and processes in Meridiani Planum.

Project Description: This project uses orbital and surface images to investigate the degradation of rover tracks over time to better understand the local scale aeolian environment. We start by identifying locations where rover tracks are seen on the martian surface (henceforth referred to as study sites) in images from the High Resolution Imaging Science Experiment (HiRISE). Overlapping images at each study site provide an opportunity to bound the time needed to resurface regolith disturbed by the rover from normal aeolian activity, settling of dust particles out of the atmosphere, or dust storm activity (i.e., Figure 1). Additionally, we use images taken by the rover at each study site to characterize surface properties and understand resurfacing rates over different types of terrain.

Current Work: A detailed review of the 44 HiRISE images covering Opportunity's ~45 km traverse has identified 15 study sites (shown in Figure 2) where tracks are clearly visible in HiRISE images. Additional locations of Opportunity's tracks may exist throughout the traverse but the sites shown in Figure 2

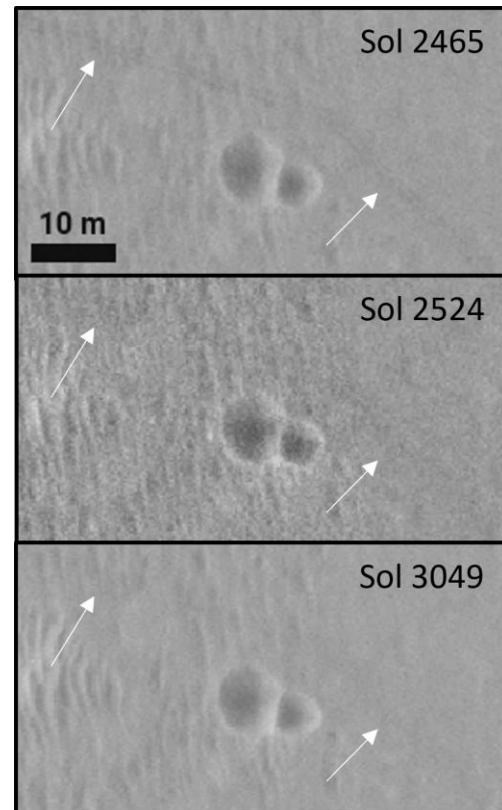


Figure 1: HiRISE images show Opportunity's degrading tracks identified at study site L. The Mars day (i.e. sol) of the MER mission shown is indicated in the upper right of each image and white arrows indicate the track location through time.

provide the best examples for study. It should be noted that we have adopted 2 sites from [10], who investigated the first 2000 sols of the MER mission, and we extend the temporal coverage over these sites to the end of the MER mission (i.e., Sol 5111).

Figure 3 shows the extensive temporal coverage of HiRISE images at each study site that we will use to monitor changes in rover tracks. The y-axis in Figure 2 starts at Sol 950 because Opportunity began operating in 2004 while HiRISE did not begin its mission at Mars until 2006. The horizontal dashed line marks Sol 2000 and is used to show the HiRISE images available before and after the publication of [10].

In addition to orbital images, we have used Opportunity's Navcam, Pancam, Front- and Rear Hazcam, and Microscopic Imager instruments [11] to assess the type of terrain present at each study site. After compar-

ing the surface material across all 15 study sites, 3 general terrain types emerged: ripples over bedrock, unconsolidated regolith, and a transition zone from ripples to unconsolidated sediment. The study sites in Figure 2 are color coded by terrain type and will provide important context for understanding how quickly Opportunity's tracks degrade over time.

Ongoing Work: We will compare relative albedo in HiRISE images over each study site to make a quantitative assessment of the degradation of Opportunity's tracks. To make this comparison, a MATLAB script developed for use in [12] will be utilized that rescales the pixel brightness from one HiRISE image to match another reference image. With the relative albedo (i.e. brightness) matched between two images, we will be able to see if and by how much tracks left by the rover have degraded over time.

After our analysis of Opportunity's traverse is complete, we will use the same workflow to analyze

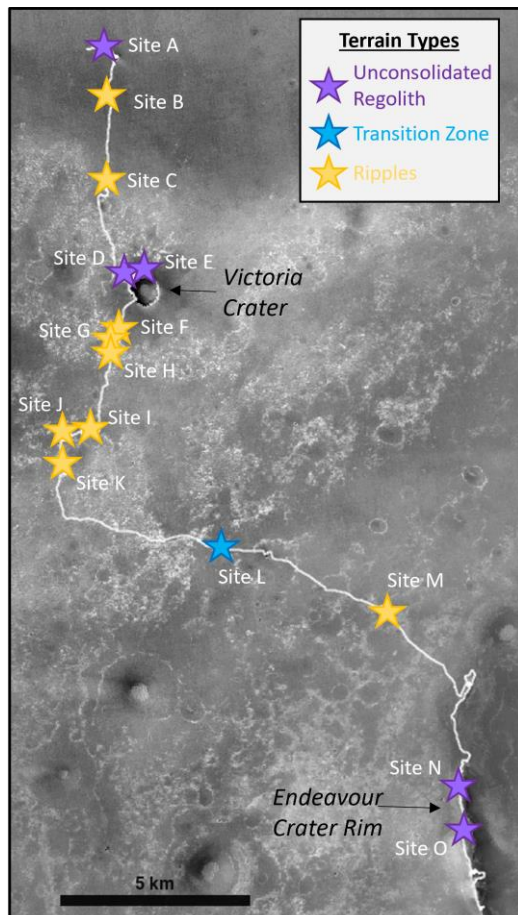


Figure 2: An overview of Opportunity's traverse (white line) is overlaid on CTX image N08_065566_1778_XI_02S005W. Study sites are labeled A-O and identified by colored stars that correspond to 3 generalized terrain types.

tracks from other rovers. Comparing track degradation across multiple rover traverses will provide us with a broader view of aeolian resurfacing on Mars.

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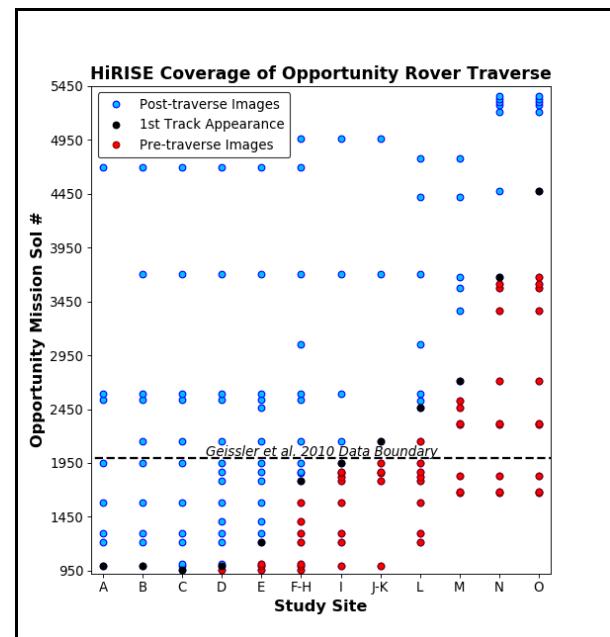


Figure 3: HiRISE coverage of the 15 identified study sites spanning the entire MER-B mission. For each study site, pre-traverse images are shown in red, the first appearance of tracks is shown in black, and the post-traverse images are shown in blue.