MARTIAN ROVER TRACK MONITORING - A HELPFUL TOOL TO UNDERSTAND AEOLIAN ACTIVITY. J. M. Widmer[1] and M. Day[1], [1]University of California, Los Angeles (jacob.m.widmer@gmail.com)

Introduction: Present-day activity on the Martian surface is dominated by wind outside of the polar regions [1]. Over the past several decades, rovers and landers have provided detailed, local-scale views of aeolian activity with in-situ measurements across a variety of terrain types [2-5]. Unfortunately, these measurements are sparsely distributed over the Martian surface making it difficult to extrapolate information about the wind on Mars [6]. More commonly, aeolian activity is studied with orbital images and interpretations of wind-formed geomorphology at the surface [7-9]. In this work, we combine surface and orbital observations, along with the surface disruption caused by rovers (tracks) to study aeolian reconstitution timescales across different traversed terrains on Mars.

Project Description: As rovers move across the surface they leave behind tracks in the form of troughs in the regolith such as those shown in Figure 1. Initially resolvable in high-resolution orbital images, these tracks are eventually erased by the active dust- and sand-transport on modern Mars. Previous work [10] explored the degradation of tracks left by the Mars Exploration Rovers (MER) Opportunity and Spirit during the first 2000 sols of the MER missions. They found the estimated track erasure time was ~1 Mars Year (MY) and influenced by gradual and episodic sediment transport events [10].

This work serves as an update on [11], monitoring the degradation of tracks left behind by the Opportunity and Spirit rovers with new locations of tracks and additional data coverage over the latter half of the MER missions. We combine orbital (HiRISE) and surface (Pancam, Navcam, Hazcam, and Microscopic imager) images to investigate the degradation of rover tracks over time to better understand the local scale aeolian environment. HiRISE images are used to monitor degrading tracks over time while images taken by each rover are used to characterize the surface material.

Results from Opportunity: Based on an analysis of 10 locations along Opportunity's traverse, we found that local resurfacing occurs over timescales of 1-5 MY (Figure 2a). Images from Opportunity's onboard cameras were used to classify the surface material encountered during the traverse into three generalized terrain types: Ripple Terrain, Unconsolidated Regolith, and a Transition Region between the first two terrains. Track locations classified as Ripple Terrain were observed to last either <1 MY or ~2 MY. Tracks created in Unconsolidated Regolith terrain persisted for ~2 MY on average. Deviations in this resurfacing time are observed at study sites C and I which exist for 5.5 MY and ~1 MY, respectively. These results are consistent with [10] which reported Opportunity's tracks degrading on timescales of ~1 MY but did not have access to the extended HiRISE coverage which has accumulated in the past 12 years.

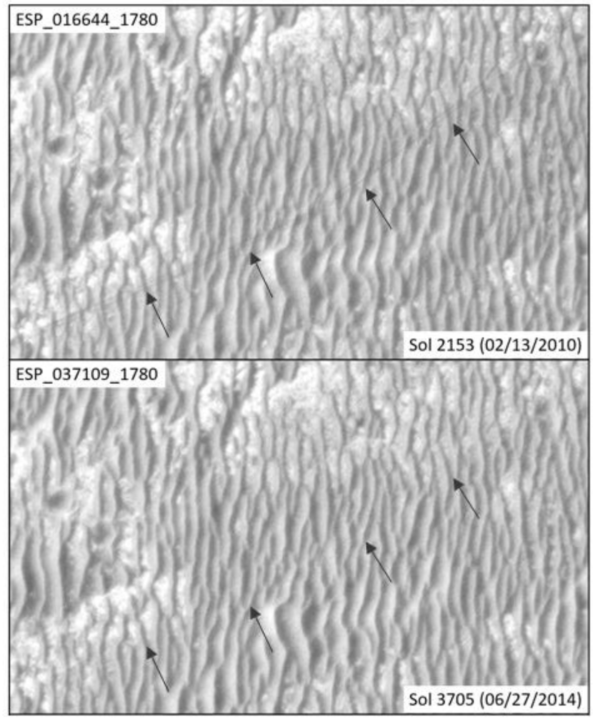

Figure 1: *Opportunity's tracks across ripple terrain as seen from HiRISE at study site F. Image ESP_016644_1780 shows the tracks just after they were emplaced while image ESP_037109_1780 shows the tracks are nearly erased after 1552 Sols.*

Results from Spirit: An analysis of eight locations along Spirit's traverse yielded resurfacing timescales of ~1 MY (Figure 2b). Images from Spirit were used to classify the terrain at each of the eight track locations into two general types: Ripple terrain (also seen along Opportunity's traverse) and Armored Regolith. The Armored Regolith classification can be further subdivided into 0-50% clast coverage of the surface and 50-100% clast coverage. Percentage of clast coverage has been a useful metric in understanding the likelihood that Spirit's wheels created an indentation in the regolith that can later be seen with HiRISE.

On average, the resurfacing rates at Spirit are much faster than the rates observed for Opportunity. Most of the sites studied (six of eight) along Spirit's traverse show the track was completely erased after ~1 MY which is consistent with previous work [10]. Surface material for these six locations spanned Ripple and Armored Regolith terrain types. The remaining two locations, study sites G and H, have been classified as Armored Regolith with 0-50% clast coverage and show tracks existing for 1.5 MY and 6.5 MY, respectively. Analysis of these locations relied heavily on HiRISE images taken after the publication of [10].

Ongoing Work: Moving forward, we will use the same workflow to analyze tracks from the Mars Science Laboratory Curiosity and Mars 2020 Perseverance rovers. Inclusion of these missions will provide an opportunity to compare additional terrain types, resurfacing timescales, and regions on Mars.

References: [1] Diniega S. et al. (2021) *Geomorphology*, 380, 107627. [2] Arvidson R. E. et al. (2006) *JGR*, 111, E02S01. [3] Arvidson R. E. et al. (2011) *JGR*, 116, E00F15. [4] Vasavada A. R. et al. (2014) *JGR*, 119, 1134-1161. [5] Farley K. A. et al. (2020) *Space Sci. Rev.*, 216, 142. [6] NEX-SAG (2015) *MEPAG report*, 1-77. [7] Hayward R. K. et al. (2014) *Icarus*, 230, 38-46. [8] Fenton L. K. and Hayward R. K. (2009) *Geomorphology*, 121, 98-121. [9] Bridges N. T. et al. (2007) *Geophys. Res. Lett.*, 34, L23205. [10] Geissler P. E. et al. (2010) *JGR*, 115, E00F11. [11] Widmer J. M. and Day M. D. (2021) *LPSC 53*, Abstract #1662.

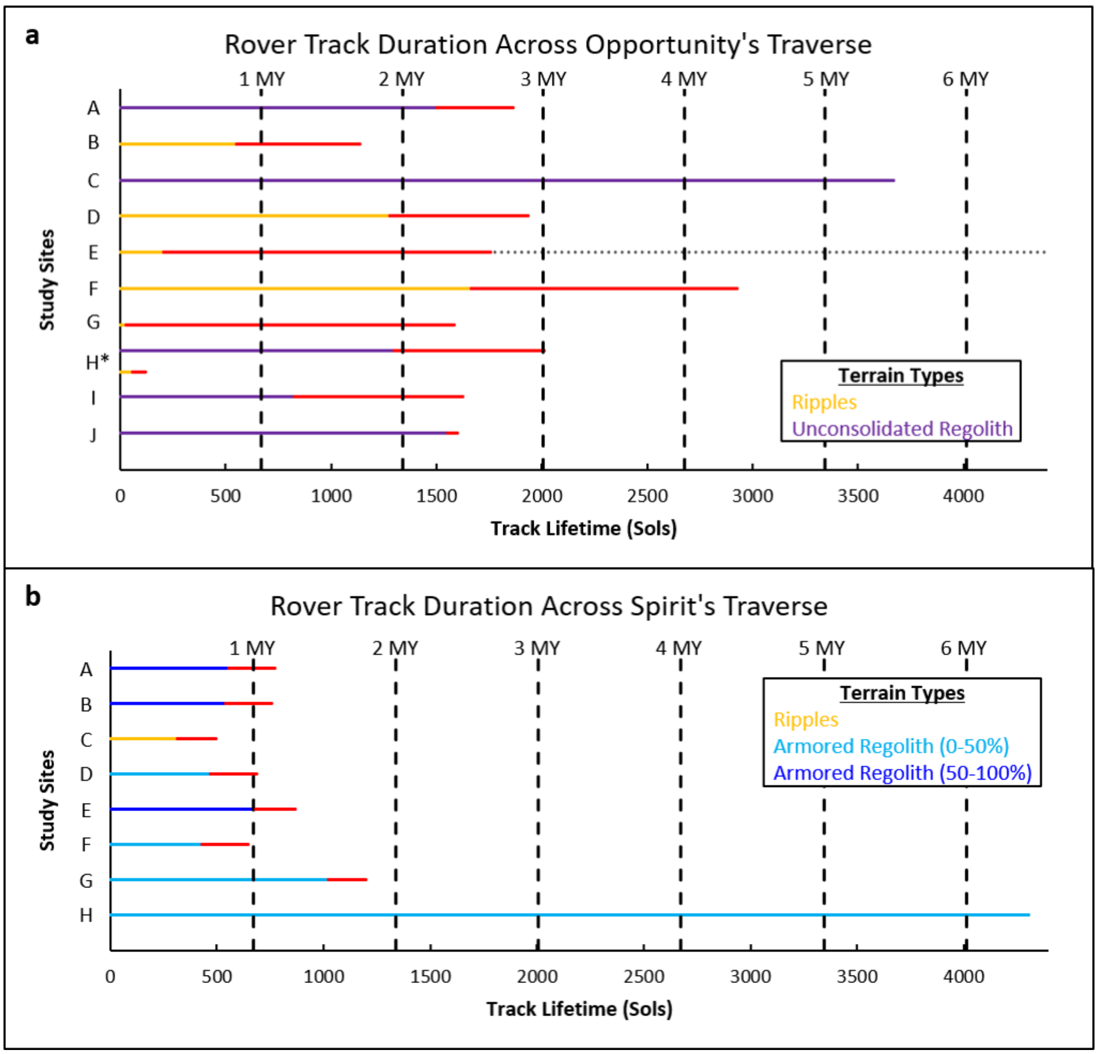

Figure 2: *Resurfacing rates for tracks made by the Opportunity (a) and Spirit (b) rovers. The duration of each track is colored coded to the terrain type and represents the segment of time a track is visible in HiRISE images covering each study site. Red lines represent the period during which the observed track was erased. Study sites below the gray horizontal dashed line in a) were seen after the publication of [10].*