ACTIVE AEOLIAN PROCESSES ALONG CURIOSITY'S TRAVERSE. S. Silvestro[1], D. A. Vaz[2,3], A. P. Rossi[4], J. Flahaut[5], L. K. Fenton[1], R. Ewing[6], and P. E. Geissler[7], [1]SETI Institute, Carl Sagan Center, 189 N. Bernardo Avenue, Mountain View, CA, USA (ssilvestro@seti.org), [2]Center for Geophysics, University of Coimbra, Portugal, [3]CERENA, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal, [4]Jacobs University, Bremen, Germany, [5]Laboratoire de Géologie de Lyon, Université Lyon 1, Villeurbanne, France, [6]University of Alabama, Department of Geological Sciences, Tuscaloosa, AL, USA,[7]US Geological Survey, Flagstaff, AZ, USA.

Introduction: Gale Crater is the landing site of the Mars Science Laboratory (MSL) mission to Mars (Fig. 1). This crater has been subject to a wide range of geological processes that gave rise to the dramatic variability of terrains observed from orbit [1]. Among these processes the action of the wind appears to have played a dominant role for much of the crater's history, as indicated by the abundance of aeolian features at this site [1,2,3]. In the NW portion of the crater floor, dark sand dunes are organized in a dune field crossing the landing ellipse from the NE to the SW (Fig. 1a). Recent observations of the migration of dark dunes and ripples throughout the Martian tropics have provided a wealth of new information on the sediment transport dynamics and wind regime at the surface of Mars [4,5,6,7] and similar analyses can provide precious indications about the current wind regime in the landing site. We analyzed three overlapping HiRISE images in MSL's landing site. These data, together with the morphology and orientations of the dark dunes and ripples, allow us to reconstruct the wind regime across the rover traverse, for the first time providing the opportunity to use ground measurements from the MSL Rover Environmental Monitoring Station (REMS) to test the accuracy of a wind regime derived from orbital data.

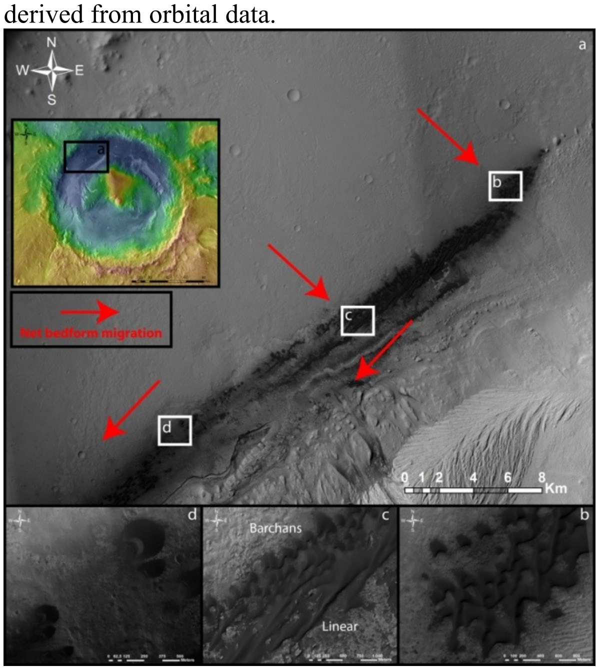

Fig. 1: Dune morphology in the study area

Methods: We performed our analysis over three orthorectified overlapping HiRISE images that were co-registered in ArcGIS using bedrock as reference. The images have been processed in ISIS and were acquired with minimal difference in lighting conditions in 2006 (T1), 2008 (T2) and 2011 (T3). CTX images have been used as context. The ripple pattern is mapped automatically using part of the methodology introduced by [8]. Ripple displacements were calculated along the whole ripple crest for 180 ripples over 5 dunes. CRISM data available over the area were processed as in [9] to derive mineralogical composition for the dunes.

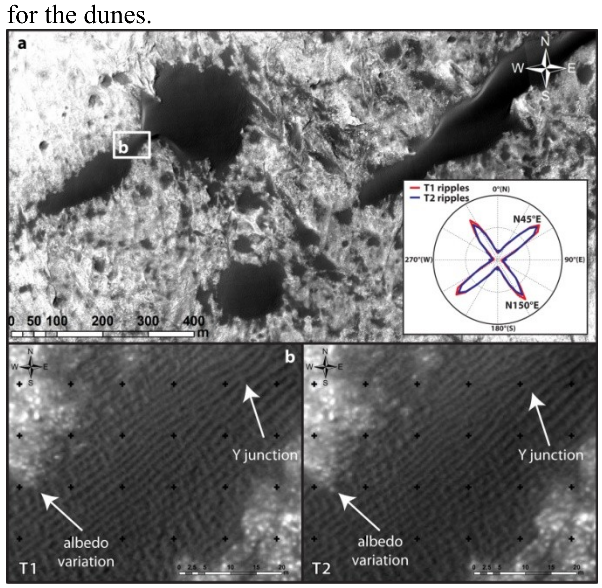

Fig. 2: ripple pattern and sand movement in the Site 1

Dune morphology and ripple pattern: The dark dunes in the MSL landing site consist of dark sand enriched in mafic minerals (olivine and high-calcium pyroxene) as seen with CRISM. Their morphology is quite complex as it changes, moving toward the SW. Simple barchan dunes with SE facing slip faces are visible in the NE margin of the erg (Fig. 1b). In the central part of the erg, barchan dunes evolve to linear or oblique features close to the central mound (Fig. 1c). Further to the SW, the dune field is dominated by simple barchans with SW-facing slip faces (Fig. 1d). A schematic representation of the net sand movement direction solely based on dune morphology is visible in Fig. 1a. However, because the wind regime is not strictly uni-directional, the dune morphology is not representative of individual wind directions [10]. Ripples rather than dunes give us more precise information about the wind regime in the study area and are analyzed in two different sites. *Site 1:* the ripples superposing three dunes (Fig. 2a) were mapped automatically and their orientations are plotted in the circular diagram shown in the inset. Two orthogonal patterns with modes at N50°E and N150°E are visible. The N150°E ripples migrated consistently and, while such a migration is not so evident for the N50°E pattern, it also displays significant changes (Fig. 2b). *Site 2:* at this site two classes of bedforms (dark and bright dunes-TARs) have accumulated in a canyon (Fig. 3a). The ripples (4-5 m in wavelength) consist of transverse ridges that are locally crossed by linear features (Fig. 3b). The bright bedforms (TARs) have a NW-SE trend and an average wavelength of about 17m (Fig. 3c). A steeper slope facing SW is visible (Profile AB). CRISM spectra indicate a weak hydration band suggesting that these features could be formed of the hydrated material eroded out from the central layered mound outcropping nearby [11].

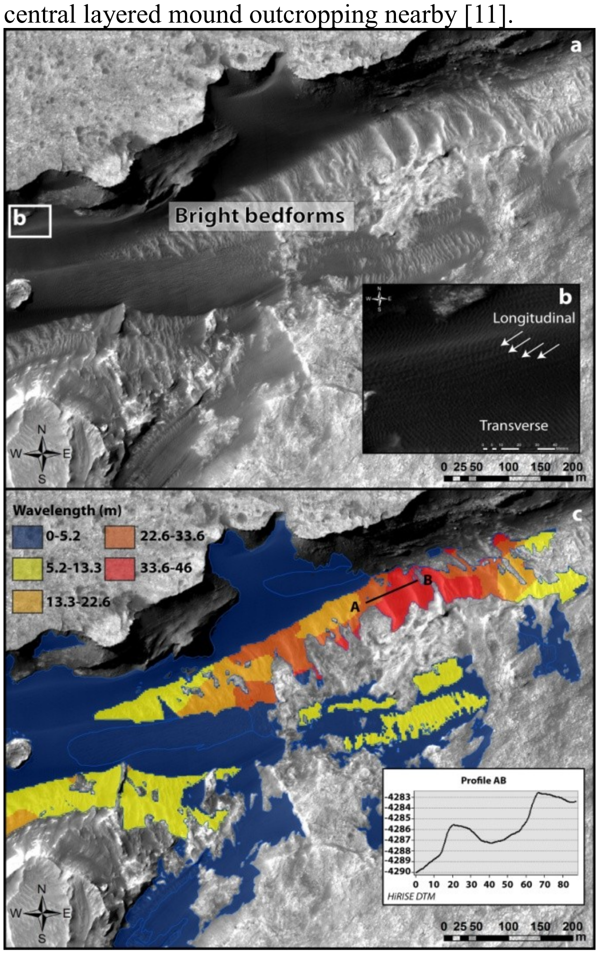

Fig. 3: Dark and bright dunes morphology and wavelength in the Site 2.

Ripple migration: The dark ripple pattern changed consistently between T1 and T2 with the N150°E ripples migrating 1.16 m on average in one Martianyear (0.58 m/Earth year) toward the SW. This value of displacement is comparable to migration rates in other tropical zones of Mars [4,12]. The N50°E ripple pattern is also changing suggesting a multi-directional wind regime. Conversely, the bright bedforms in site 2 didn't display significant movement.

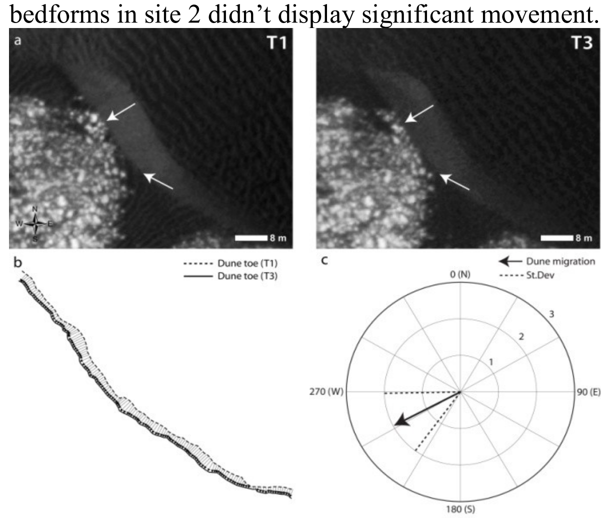

Fig. 4: Dune migration magnitude and direction.

Dune migration: Dune migration is evident comparing the image pair T1-T3 (Fig. 4). The rate of migration for eight dunes in the SW margin of the dune field was calculated averaging the vectors linking the dune toes at T1 and T3 as visible in Fig. 4b. An average migration of two meters toward the SW has been calculated for the study dunes, suggesting a rate of migration of 0.4 meter/Earth year (about 0.8 meter/Mars year) (Fig. 4c).

Conclusion: We identified consistent ripple and dune migration caused by strong winds from the NE in the MSL landing site. Because Curiosity will drive through these dunes, it may eventually experience such winds. This will be an opportunity to measure the threshold friction velocity of sand saltation, a key factor for determining erosion rate and sand fluxes on Mars. Such activity however, could represent a threat to the rover, and care should be taken in selecting the safest traverse.

References: [1] Anderson R. B. and Bell J. F. (2010) *Mars, 5,* 76-128. [2] Hobbs S. W. et al. (2010) *Icar.,210,* 102-115. [3] Silvestro S. et al. (2010) *LPS XLI,* Abstract #1533, 1838. [4] Silvestro S. et al. (2010) *Geophys. Res. Lett., 37,* L20203. [5] Chojnacki M. et al. (2011), *JGR, 116*, E00F19. [6] Silvestro S. et al. (2011) *Geophys. Res. Lett., 38,* L20201. [7] Bridges et al. (2012), *Geology, 40*, no.1. [8] Vaz D. A. (2011), *PSS, 59*, 1210-1221. [9] Murchie S. L. et al. (2009) *JGR, 114*, E00D07.[10] Rubin D. M. and Ikeda H.(1990), *Sedimentology, 37*, 673-684. [11] Milliken R. E. et al. (2010), *GRL, 37,* L04201. [12] Geissler P. E. et al. (2011) *LPS XLII,* 2537.