RIPPLE MIGRATION AND SMALL MODIFICATIONS OF ACTIVE DARK DUNES IN NILI PATERA (MARS). S. Silvestro[1] , L. K. Fenton[2], and D. A. Vaz[3], [1]International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, Pescara, Italy (simone@irsps.unich.it), [2]SETI Institute, NASA Ames Research Center, CO, USA, [3]Centre for Geophysics, University of Coimbra, Portugal.

Introduction: Are martian aeolian bedforms (ripples and dunes) capable of migration in present day atmospheric conditions? This is one of the major questions regarding the aeolian processes on the red planet. Although sparse evidence of dune activity [1, 2, 3] and ripple migration [4] have been recently detected on the surface of Mars, there is currently no evidence of widespread bedform migration.

Images from the High Resolution Imaging Science Experiment (HiRISE) recently revealed that, as it occurs on the Earth, smaller ripples are superposed on the slopes of martian dark sand dunes [5]. However, if the dark sand dunes are presently active, the migration of the ripples should be potentially detected using multitemporal hi-res images. Here we test such hypothesis analyzing two HiRISE images that provide multitemporal observations of a dark erg consisting of barchan and barchanoid dunes (Fig. 1) in Nili Patera. The latter dunes, with sharp brink and crests [6], are among the best candidate sites for the identification of bedform migration and overall dune activity.

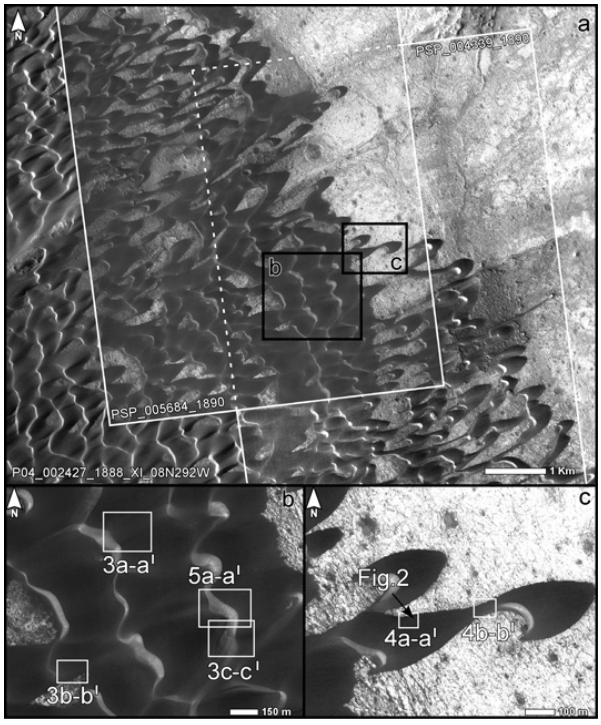

Fig. 1. Location map of the study area.

Methods: Two overlapping HiRISE images (PSP_004339_1890 and PSP_005684_1890) were processed and co-registered with the CTX P04_002427_1888_XL_08N292W (Fig. 1) into a Geographic Information System (GIS) environment. The HiRISE have been acquired the 30 June and 13 October 2007 at Ls=267.5° (late autumn) and Ls= 330.0° (winter), respectively. A semiautomatic algorithm for ripple identification was used to extract ripple limbs and to search for changing ripple patterns [7,8,9] (Fig. 2).

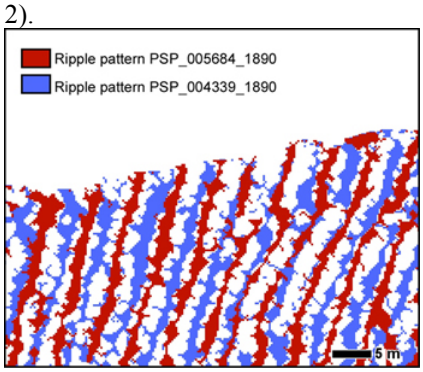

Fig.2. Examples of ripple patterns extracted by using the semiautomatic algorithm on Fig. 4a-a^{I}.

Results: Three different kinds of dune modifications were detected in the study site: *1) Changes in the ripple pattern* are visible at the ripple crest terminations in Fig. 3, based on the modification of the Y junction (by the process of defect migration [10,11,12]). Y junction are displaced westward in the observed examples (Figs. 3a, a^{I} and 3b, b^{I}). Ripple crests are outlined in yellow and major modifications in blue. In Fig. 3c, c^{I} we highlighted the movement of the ripple (outlined in blue) toward the dune crest (in green). In Fig. 4 a, a^{I}, we observed the displacement of the ripple crest with respect to the fractures on the substrate (outlined in white). Assuming that the displacement of the ripple crests would be less than one crest wavelength, we calculated a migration of ~2 m toward the WSW. This represents to date the higher value of bedform migration ever measured on Mars. *2) Changes in the shape of the dune edges* are visible in Fig. 4a, a^{I} and 4b, b^{I}. The edge of the dunes (outlined in green) changes significantly in the two HiRISE suggesting active sand saltation at this site. *3) Changes in the slip face structures* (Fig. 5a, a^{I}), we can observe that several new rectilinear streaks occurred on dune slip face (see Fig. 1 for location). We interpret these features as new grainflow events [13] suggesting consistent dune activity between late autumn and winter.

Discussion: The changes in the position of the Y junctions and in the edges of the study dunes (Figs. 3,

4), indicate that sand transport occurred in the study area. The ripple migration was likely forced by the same ENE winds affecting the whole dune field. The capability of sand to move on the Martian surface has been discussed by [4] as a factor controlled by the pervasive indurations of the regolith and the frequency of wind events having sufficient energy to saltate sand. Ripple migration at this site suggests that dune surfaces are not heavily crusted or indurated. This suggests that saltation events, possibly caused by high-energy atmospheric phenomena like dust storms, are frequent enough to prevent the formation of a thick stabilizing crust. The occurrence of new grainflow scars on dune slip faces in Nili Patera indicates that not only ripples, but also the whole dunes, are actually migrating. Furthermore, the lack of prominent erosional features (fractures and mass wastings) suggests that these dunes are active for the most part of the year.

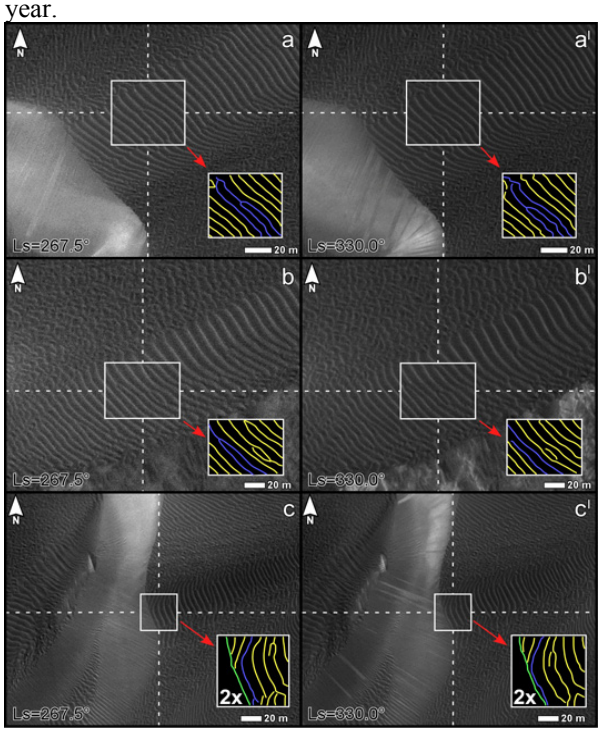

Fig. 3. Modifications of the ripple pattern in the study site. Ripples are outlined in yellow. Major changes in the ripple pattern are outlined in blue. c-c^{I}) dune crest is outlined in green. a, b, c) HiRISE PSP_004339_1890; a^{I}, b^{I}, c^{I}) HiRISE PSP_005684_1890.

Conclusion: The ripple migration observed in this study is the first evidence of widespread bedform migration detected from orbital data and suggests that: 1) the surface of the dunes in the study area are not heavily cemented or crusted 2) high stress winds blow from the ENE between late autumn and winter. Other evidence of overall dune activity includes the modification of the dune edges and the occurrence of new grainflow scars over dune slip faces. Collectively, our results, indicate that sustained sand saltation occurred in the study area and that dark dunes in Nili Patera are active in present day atmospheric conditions. A global search for ripple movement over the Martian dark sand dunes will be performed in the future to better constrain the migration rate of the wind ripples and the geographical distribution of the active dark dunes on Mars.

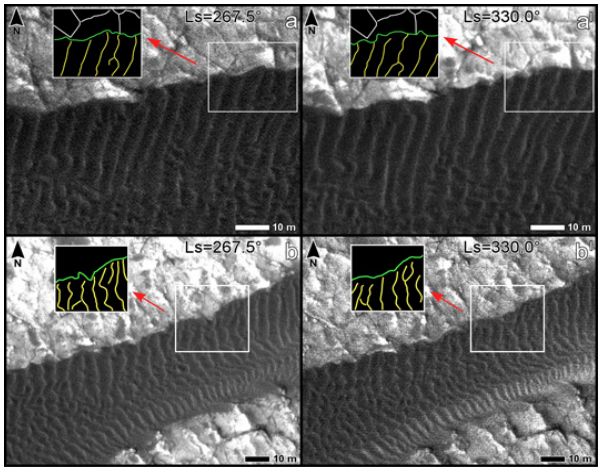

Fig. 4. Modifications of the ripple pattern and of the dune edges. Ripple crests are outlined in yellow, fractures in the bedrock in white and the dune edges in green. a, b) PSP_004339_1890; a^{I}, b^{I}) PSP_005684_1890.

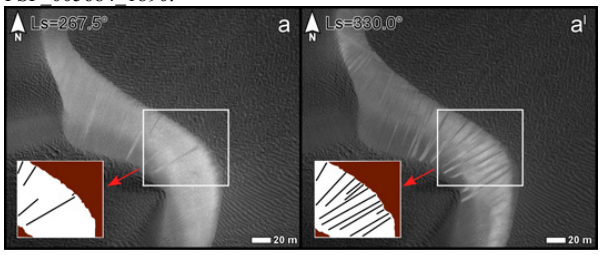

Fig. 5. Modifications occurred over dune slip faces. Several new grainflows (in black) occurred over the dune slip face (in white). Dune stoss side in brown. a) PSP_004339_1890; a^{I}) PSP_005684_1890.

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