AEOLIAN LANDFORMS IN THE EXOMARS LANDING SITE, A REGIONAL PERSPECTIVE.

S. Silvestro[1,2], D.A. Vaz[3], M. Chojnacki[4], D.C.A. Silva[3], A. Botteon[5], D. Tirsch[6], F. Salese[7], C.I. Popa[1], M. Pajola[8], G. Franzese[1], G. Mongelluzzo[1], F. Cozzolino[1], C. Porto[1], F. Esposito[1]. [1]INAF, Osservatorio Astronomico di Capodimonte, Napoli, Italy (simone.silvestro@inaf.it). [2]SETI Institute, Mountain View, CA, USA. [3]CITEUC, University of Coimbra, Portugal. [4]Planetary Science Institute, Lakewood, CO, USA. [5]Università G. d'Annunzio, Chieti-Pescara, Italy, [6]Institute of Planetary Res., DLR, Berlin, Germany. [7]Centro de Astrobiología, CSIC-INTA, Madrid. [8]INAF, Osservatorio Astronomico di Padova, Italy.

Introduction: The ExoMars mission is set to land in Oxia Planum (18.2° N; 24.3° W) to search for signs of past or present life on Mars and to perform long-term atmospheric investigations [1, 2]. Dust devil tracks, transverse aeolian ridges (TARs) and periodic bedrock ridges (PBRs) have been described in and around the landing site suggesting that the wind action had, and still has, a key role in shaping the surface [3, 4]. Here we push our investigation further by looking for other aeolian features in the landing area and, to put these observations into an appropriate atmospheric context, we analyze aeolian features in McLaughlin and Oyama, two impact craters located ~200 km and ~400 km NE from the landing area respectively (Fig. 1a).

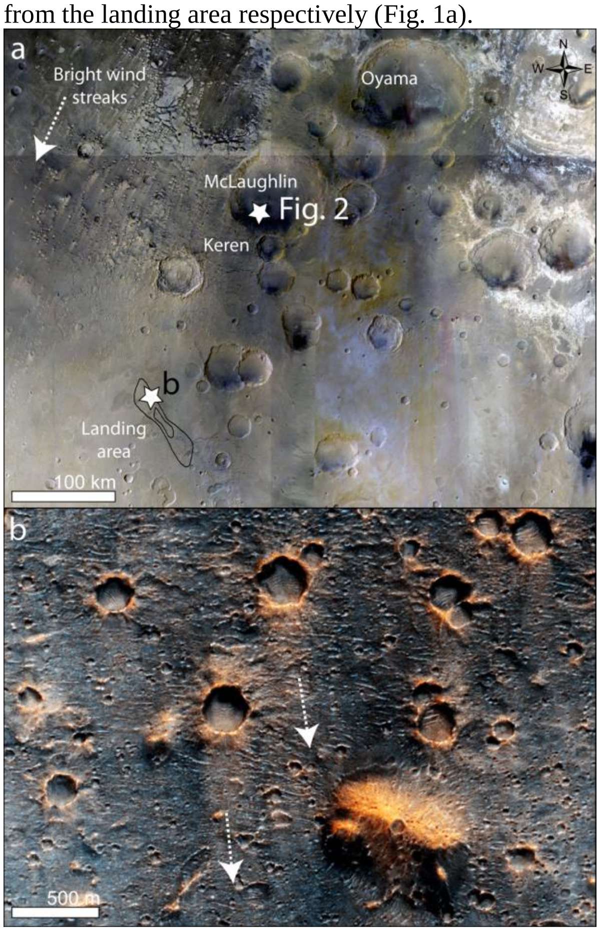

Fig. 1: a) Study area, note the bright-toned streaks indicating the regional winds (HRSC color mosaics). **b)** Wind streaks in the landing area (CaSSIS RGB image MY35_007623_019_0).

Methods: The landing area and its surrounding were analyzed with HRSC, CaSSIS, CTX and HiRISE images in a GIS environment. Dune movement was tracked on orthorectified HiRISE time-series in McLaughlin and Oyama craters and sediment fluxes were computed using the method of [5].

Results: Previous work has highlighted the presence of a complex aeolian pattern in the landing area formed by differently oriented PBRs and TARs [3, 4]. Modern wind directions were deduced from dust devil track orientations, indicating winds blowing from the W-WNW or E-ESE [4]. Thanks to the careful analysis of CaSSIS and HiRISE images, here we report the presence of bright- and dark-toned aeolian streaks indicating winds originating from the NNW-NNE (Fig. 1) and from the E-ESE. Wind streaks having similar orientations are visible outside the landing ellipse suggesting a regional nature for these flows. *McLaughlin and Oyama*. McLaughlin is a 92-km-large crater with a depth of 2.2 km. Like the landing area, its floor shows fan deposits and an enrichment in clay minerals [6, 7]. Here we highlight another important similarity, the presence of the same PBRs/TARs complex pattern reported in Oxia (Fig. 2). A field of high-flux barchans [8] is accumulated on the crater's southern floor over the ejecta of Keren crater [6, 7]. The ejecta deposit represents a roughness element that is controlling the accumulation of the dunes in this area (Fig. 3a). Previous flux estimations computed on a 2008-2016 image couple [8] are refined here using a co-registration algorithm, which computes the bedrock apparent displacements and corrects the location of the advancing slipfaces. Dune flux (median=3.1 $m^2\ yr^{-1}$) is strongly controlled by the local topography like other areas on Mars [9] (Fig. 3a). Dune morphology and migration direction are consistent with the wind streaks visible in the area (Figs. 1 and 3a). Even in Oyama, a 100-km large (~2 km-deep) impact crater (Fig. 1a), we found evidence for a set of regularly spaced E-W trending PBRs underlying a field of scattered barchans [10]. Dunes migrated toward the South in a 2013-2019 time-range with a flux (median=3 $m^2\ yr^{-1}$) similar to McLaughlin (Fig. 3b).

Discussion: By identifying PBRs and TARs outside the landing area, we show that winds that formed these features in Oxia Planum were common across the region. This indicates that the wind that eroded the

PBRs was not localized, but rather part of a persistent regional wind regime and that even the wind directional change that leaded to the accumulation of TARs was regional in nature.

Dune migration orientations and fluxes in McLaughlin and Oyama, together with the presence of southerly-oriented wind streaks, indicate that even present day winds in the landing area are blowing regionally. A preliminary analysis of GCM output from the MGD[3] [11] show that some of these winds are predicted to blow in northern autumn, between L_S 235° and 258°. The ExoMars lander is equipped with a meteorological station [2] providing the opportunity to measure these winds in situ. This will give important constraints on the frequency of streak-forming winds and their ability to move sand at the surface [12]. In addition, a close inspection of the complex PBR/TAR pattern by the lander and/or the rover, will shed light on PBR formation mechanism [13, 14] and Martian climatic changes [3, 15, 16].

Fig. 2: Complex pattern in McLaughlin crater formed by PBRs (NW-SE) and TARs (ENE-WSW). See Fig. 3a for location (HiRISE IRB ESP_030266_2020).

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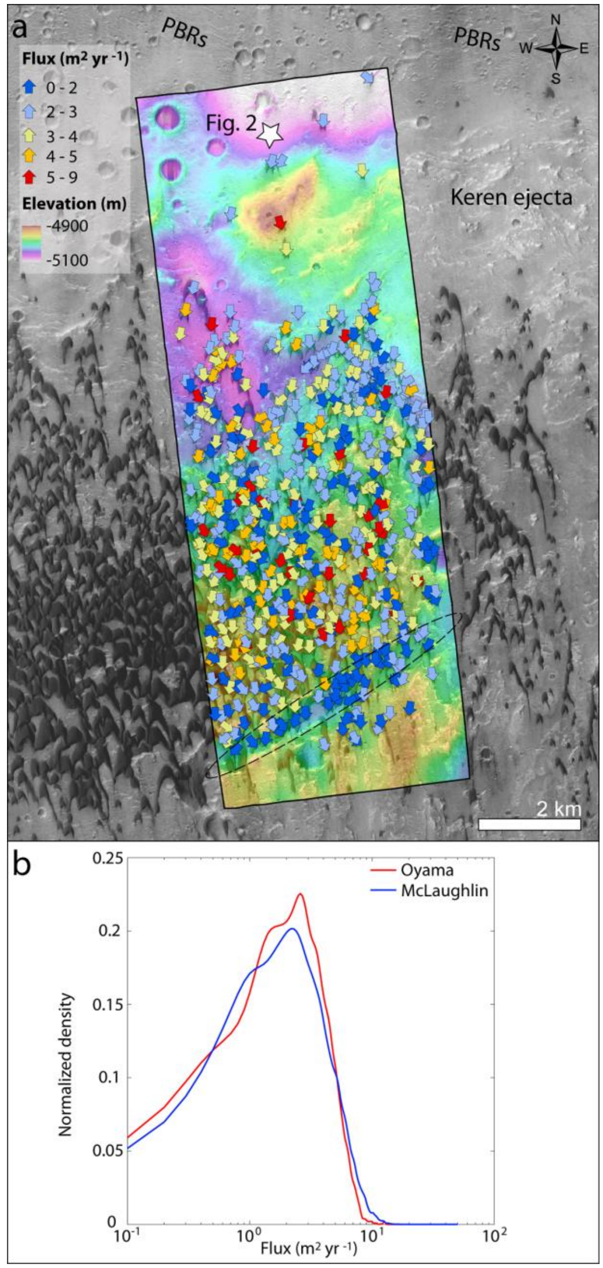

Fig. 3: a) Dune migration in McLaughlin crater. Note the drop in flux for the dunes moving over the southern NE-SW oriented trough (dashed ellipse). (HiRISE ESP_045312_2020_RED in transparency over DTM DTEEC_036859_2020_036569_2020_A01). **b)** Flux distribution for the McLaughlin and Oyama dunes. McLaughlin T1=PSP_009814_2020_RED, T2=ESP_045312_2020_RED, Oyama T1= ESP_034815_2035_RED, T2= ESP_061571_2035_RED.