WIND STREAKS IN THE EXOMARS 2028 LANDING SITE. S. Silvestro[1,2], D.A. Vaz[3],1, F.M. Grasso[4], D. Tirsch[5], E. Favaro[6], Y. Caddeo[7], F. Salese[7], C.I. Popa[1], G. Franzese[1], G. Mongelluzzo[1], C. Porto[1], M. Pajola[8], 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]CNR ISAC Lecce, Italy. [5]Inst. Planetary Res., DLR, Berlin, Germany. [6]ESA/ESTEC, Noordwijk, the Netherlands. [7]IRSPS, Università G. d'Annunzio, Chieti-Pescara, Italy, [8]INAF, Osservatorio Astronomico di Padova, Italy.

Introduction: The ESA ExoMars mission will land at Oxia Planum to search for signs of life on Mars [1, 2] (Fig. 1a). Aeolian processes play a significant role in shaping the landing surface, evidenced by documented features like dust devil tracks, bright bedforms (transverse aeolian ridges [TARs]), and erosive wind-formed ridges (periodic bedrock ridges [PBRs]) [3-6]. However, little attention has been paid to wind streaks, which are abundant in the landing site and provide valuable insights into recent climatic conditions. These features are the focus of our attention (Fig. 1).

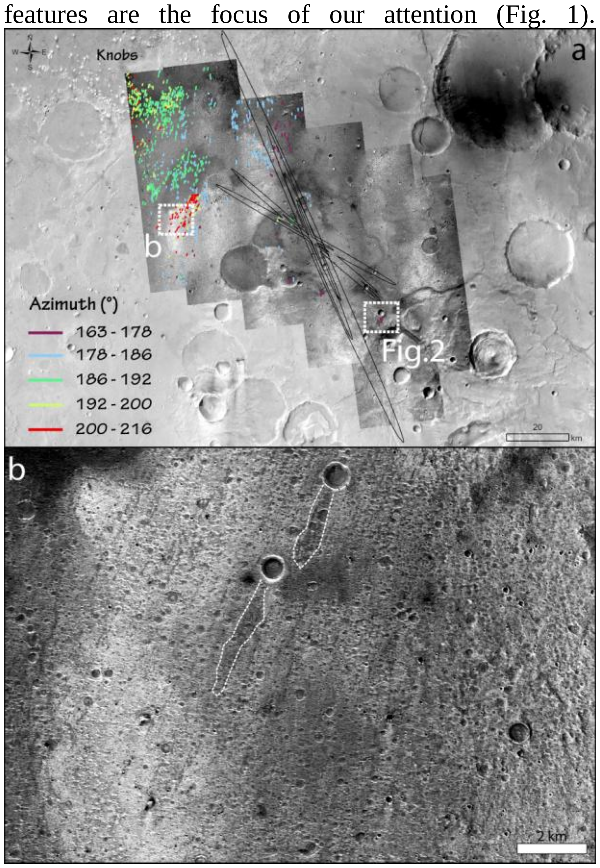

Fig. 1: Mapped wind streaks and stripes (n = 954) in Oxia Planum. **a)** The study area is limited by the Context Camera (CTX) mosaic, which was used for mapping the streaks and integrated with CaSSIS data. Wind streaks are colored by their azimuth (°). **b)** Dark, elongated stripes are better preserved in the lee of impact craters and were formed by winds coming from the NE.

Methods: A total of 954 wind streaks were manually mapped in the study area within a GIS environment (Fig. 1). Mapping was performed by leveraging the broad coverage of CaSSIS (4 m/pixel) and CTX (6 m/pixel) mosaics, with details validated using high-resolution HiRISE images (50-25 cm/pixel). Because the main focus of this report is the wind streak orientation, data were projected using a Lambert Conformal Conic (LCC) projection centered in Oxia Planum to minimize directional distortion. The vast majority (n = 784) of the mapped features are bright-toned, while n = 170 are dark-toned, elongated streaks or *stripes*.

Results: Previous studies have documented the presence of differently oriented dust devil tracks in the landing area [4, 5]. In this work, we report the presence in the study area of different types of linear features that we interpret having an aeolian origin (Fig. 1).

Bright-toned wind streaks, oriented towards the SSW (mean azimuth 189°) and indicating winds originating from the NNW–NNE, are especially abundant in the NW sector of the study area (Fig. 1a). This spatial arrangement is likely due to the high number of local topographic obstacles (craters and knobs) in this sector, which favor the nucleation and preservation of these features (Fig. 1a). Analysis of the orientation distribution reveals slight variations, allowing us to distinguish two to three distinct sub-populations that are interpreted as being controlled by the regional topography.

Dark-toned stripes: We refer to these features as 'dark-toned stripes' to distinguish them from the classic dark wind streaks associated with topographic obstacles [8]. These stripes form a dark-toned 'streaky' pattern with a main NE-SW trend (red lines in Fig. 1b). At the HiRISE scale, they consist of elongated dark patches covering the bright, clay-enriched unit, which is the main scientific target of the mission [2]. Furthermore, the presence of small scarps suggests a degree of consolidation or cementation, similar to the 'dark patches' previously reported [9]. Interestingly, these stripes are better preserved in the lee of some ~ 600-m-large impact craters (white dashed line in Fig. 1b), suggesting formative winds blowing consistently from the NE to the SW. The resulting orientations of the dark stripes thus significantly differ from the nearby bright streaks (red/blue lines in Fig. 1a). Further analysis (Fig. 2) details the SSE-oriented dark stripes (3) found in close association with a ~2-km-large impact crater. Both

CaSSIS and HiRISE data confirm that these dark-toned stripes (3) are formed by a smooth, dark-toned ejecta blanket (2) that has been preferentially preserved along the southern rim of the crater, directly overlying the bright clay-enriched bedrock (1). The stripes exhibit fracturing and small impact craters, suggesting a degree of induration (cementation or consolidation). Their orientation is slightly divergent but similar to the bright wind streaks in this sector, suggesting control by the current regional wind regime. Crucially, a distinct dark-toned wind streak (4), likely depositional, is also observed emanating from the same crater. This streak appears as a blue sandy halo in the HiRISE color composite (Fig. 2b), underscoring the difference between these mobile, eolian features (4) and the more consolidated, ejecta-controlled dark stripes (3).

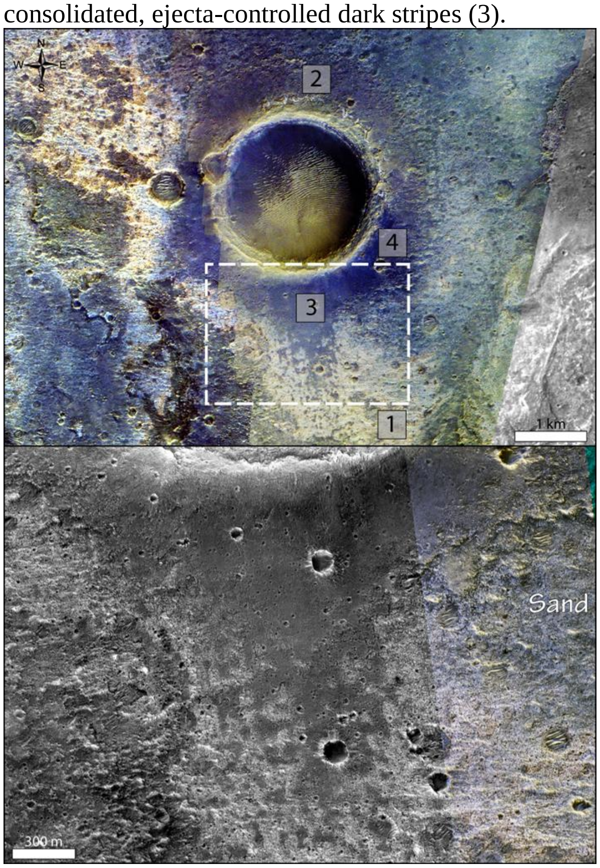

Fig. 2: a) Dark stripes (3) found in the lee of a ~ 2-km-large impact crater (**see Fig. 1a for location**). Key features labeled are: (1) Bright Noachian bedrock, (2) Crater ejecta, and (4) a dark depositional streak (Type 2 in [8]). CaSSIS NPB MY34_005012_018_2. **b)** Detail of the stripes (3), which are formed by the same smooth (at the HiRISE scale) crater ejecta blanket (2). Note the bluish area on the right, which is interpreted as a thin sand mantle and corresponds to the dark streak (4). HiRISE PSP_007019_1980 (RED & IRB).

Discussion: Our findings suggest the presence of a new class of Martian aeolian feature. Unlike all previously described wind streaks, which consist of loose material (sand, dust, or frost) [8, 10-12], the features presented here appear to be composed of consolidated material. Specifically, the dark stripes in the lee of the crater in Fig. 2 can be interpreted as an *'aeolian preservation streak'*. This feature arises from the differential erosion of a consolidated unit (crater ejecta blanket) by winds from the N-NNW, thereby preserving the ejecta in the erosional shadow of the crater rim while exposing the underlying Noachian bedrock. The orientation of this feature is consistent with the bright wind streaks in the same area, suggesting the N-NNW wind regime has been dominant in shaping the landscape over geological timescales. An alternative explanation, currently under evaluation, is the asymmetrical distribution of ejecta due to a high-angle impact. The stripes shown in Fig. 1b, particularly where they cluster behind topographic obstacles (dashed in Fig. 1b), can also be interpreted as preservation streaks. Although their degree of consolidation remains to be definitively determined (a question the ExoMars Rover might address), their orientation differs slightly from the bright streaks. This divergence suggests either a different formation timeline (if consolidated, only long-term winds could shape them) or a stronger local topographic control on the wind regime.

Conclusion: Our results show two distinct populations of streaks and suggest the presence of a new type of feature (the '*aeolian preservation streak*') composed of consolidated material, indicating the dominance of northerly winds over geological timescales; this novel hypothesis requires crucial validation by the ESA Rosalind Franklin rover.

References: [1] Vago J. et al. (2017). Astrobiology, 17. [2] Quantin et al. (2021), Astrobiology, 21. [3] Balme M. et al. (2017), PSS, 153, 39-53. [4] Silvestro S. et al. (2021), GRL, 48. [5] Favaro E. et al. (2021), JGR, 126. [6] Favaro E. et al. (2024), EPSL, 626. [7] Greeley R. et al. (1978), Icarus, 34. [8] Thomas P. et al. (1981), Icarus, 45. [9] Fawdon P. et al. (2024), Journal of Maps, 20. [10] Silvestro et al. (2014), 8th Int. Conf. on Mars, abst#1193. [11] Fenton et al. (2015). Aeol. Res.,16. [12] Silvestro et al. (2015), JGR, 120, 4. **Acknowledgement:** The results reported here were obtained in the context of the Earth-Moon-Mars (EMM) project, led by INAF in partnership with ASI & CNR, funded under the National Recovery and Resilience Plan, Mission 4, Component 2, Investment 3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures" Action 3.1.1 funded by the EU, NextGenerationEU.