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UNEXPECTED AEOLIAN BUILDUP ILLUSTRATES LOW MODERN EROSION ALONG ZHURONG TRAVERSE ON MARS. Z. Chen^{1,2,3}, G. Caravaca², M. Loche², B. Chide², B. Kurfis-Pál^{4,5,6}, J. Zhang^{1,3}, A. Cousin², O. Forni², L. Guo^{1,3}, J. Lasue², D. Liu¹, J. Liu^{1,3}, X. Liu⁷, Y. Luo^{1,3}, X. Ren¹, W. Xu⁷, Q. Zhang^{1,3}, Y. Zhang^{1,3}, R. Shu⁷, A. Kereszturi^{4,5,8}, S. Maurice², and C. Li^{1,3}. ¹National Astronomical Observatories, CAS (chenzp@nao.cas.cn), ²Institut de Recherche en Astrophysique et Planétologie, CNRS, ³University of Chinese Academy of Sciences, ⁴Konkoly Astronomical Institute, ⁵MTA Centre of Excellence, ⁶University of Tokyo, ⁷Shanghai Institute of Technical Physics, CAS, ⁸European Astrobiology Institute

Introduction: The erosion rate on Mars has been dwindling throughout its history[1]. The active aeolian abrasion supported by sands is a well-understood mechanism for modern Mars erosion[2]. Sands under relocation[2], comminution[3], or deactivation[4] can evolve toward depletion, leading to terrains dominated by even weaker erosion. This complementary aspect of Mars surface processes has not been thoroughly investigated in situ beyond early robotic missions[5, 6].

Here, in the anticipated weakly abraded landscape visited by Zhurong, Utopia Planitia, Mars[7], we report the existence of extensive covering over local blocks bearing abraded morphology of ventifacts with unusual features. We suggest a possible pathway for the formation of the covering, which is supported by our abrasion rate, material cohesion, and brine deliquescence models. The observed covering helps illustrate the characteristics of the weakly abraded landscape on modern Mars.

Observations: Representative examples (Fig.1) of the covering observed by the Zhurong's cameras show a characteristic rough, oriented texture, resembling aeolian flaking (abraded layers) or projections (protruding structures). Individual units of the texture have a typical scale of 3-6 mm and exhibit locally consistent orientations. These units sometimes coalesce into macroscopic linear composite features in parallel or radial patterns. The transition from roughness to smoothness occurs between some faces of the block. The boundaries are sometimes perpendicular to the orientation in the rough texture. The composition of the covering is similar to the local soil as indicated by the color from MSCam[8] and short wave infrared reflectance from MarSCoDe[9].

The covering material can be easily disrupted by the blast waves generated from the laser-induced plasma from MarSCoDe LIBS. We established an overpressure model modified to predict the LIBS blast wave overpressure profile in a typical observation[10]. With an example showing overlapping "fingers" from the covering, unaffected then damaged by the blast wave as they get closer to the blast location, we can estimate the cohesion for the covering to range from 0.4 to roughly 18 kPa.

Origin of the covering: The morphology of the covering indicates an aeolian origin. The inferred wind speed directions from the texture orientation range from 225° to 240° azimuths (Fig.1), aligning with the current prevalent wind regime from the North-East during winter.

The composition of the covering suggests sources related to widespread material over the local surface. In addition to the direct dustfall, fine material also forms aggregates that adhere to the blocks' surface by wind saltation[11]. The process is estimated to be more efficient than pure atmospheric dustfall by our model and to allow for enhanced material input by mobilizing both the settled dust veneer and any loose soil layer in the area.

The blast wave susceptibility of the covering indicates additional cohesion exceeding pure electrostatic force and consistent with salt cementation[12], similar to the salt-cemented crusts or clods in the soil around Viking 1[13]. We estimated that the observed concentration of perchlorate[14] and gypsum[4] on Mars could support the estimated cohesion of the covering.

The current abrasion of the covering needs to be weak enough to allow material to accumulate. We modeled that the ideal local abrasion rate under an abundant sand supply is expected to easily remove the annual aeolian accumulation. Also, this abrasion will exceed the total surface retention in the last 1.1 Ga[15] if sustained during the recent climate scenario (0.1 Ma)[16]. Together with the known local encrusted dunes[4, 17], this suggests a weak abrasion mainly due to the lack of sand supply.

A formation pathway: We propose a mode of aeolian accumulation on Mars as the Cemented Aeolian Covering (CAC). The decomposed formation pathway of CAC is shown in Fig.2: starting from an initial block (Stage 1), aeolian materials adhere (Stage 2) to its surface from two possible sources: (A) atmospheric dust deposition; (B) adhesion of sand-sized silt-clay aggregate to the surface. Further cementation (C) allows the subsequent accumulation into a millimeter-thick, smooth covering (Stage 3). The covering is largely preserved due to a weak abrasion (D). The aeolian features (Stage 4) are subtly carved into the covering without total removal. These decomposed stages could occur either sequentially or simultaneously depending on the climate scenario.

Implication and perspective: We show that the CAC is a characteristic geomorphology that could form in a weakly abraded landscape on modern Mars. It may represent a "terminal" phase of the modern Mars abrasion process under the depletion of abrasive sands, resulting in an even lower erosion rate for the modern Mars scenario. However, in this phase, the weakly abraded land-

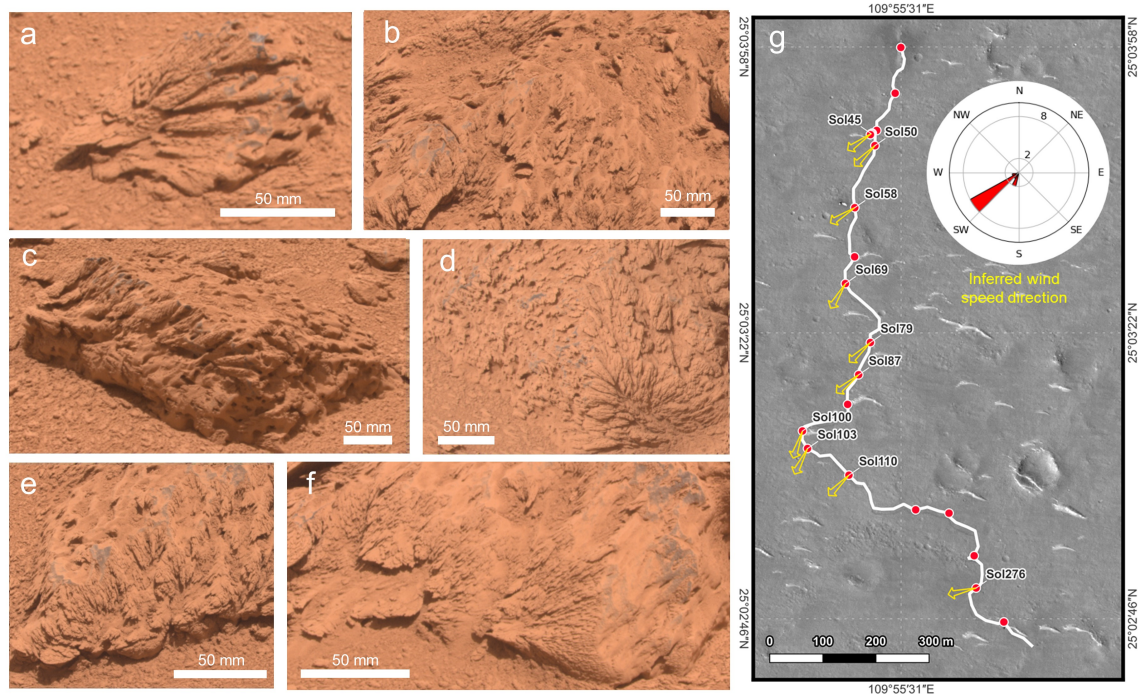


Fig. 1: (a-f) Examples of covering over blocks observed by MSCam. (g) Track of Zhurong during its first 300 sols and dotted sites with MSCam imaging. Sites where a general orientation of the abraded features can be clearly inferred with visual inspection are marked with their Sols and arrows indicate the inferred wind velocity directions. Base map by the High Resolution Imaging Camera (HiRIC) onboard the Tianwen-1 orbiter.

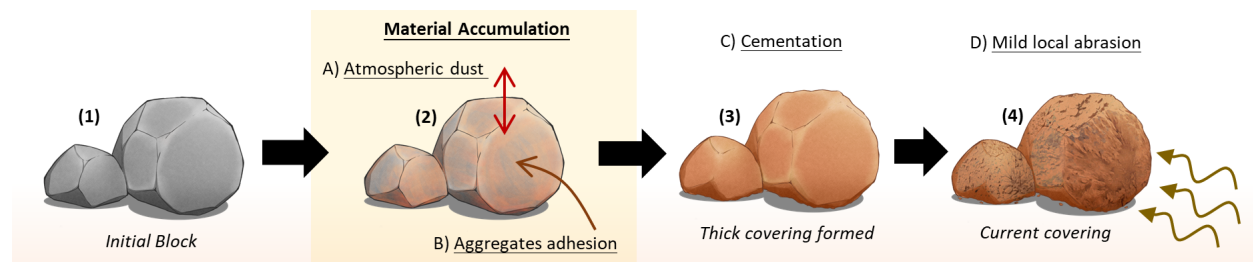


Fig. 2: Decomposed scheme of the formation of the cemented aeolian covering.

scape is not completely dormant. The local surface would experience an accumulative regime, where characteristic abraded systems carved on unconsolidated material may emerge. The possibility of active coverage, together with Zhurong's experience, should also raise awareness to the potential hazard over similar terrain in future missions.

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