AEOLIAN BEDFORMS IN THARSIS, MARS: NEW INSIGHT FROM POPULATIONS OF SMALL CRATERS. M. A. Baskakova[1], M. A. Kreslavsky[2], I. P. Karachevtseva[1]. [1]Moscow State University of Geodesy and Cartography (MIIGAiK), Gorokhovskiy per., 4, 105064, Moscow, Russia e-mail: guzelkamar@mail.ru; icar2003@mail.ru [2]University of California - Santa Cruz, 1156 High Street, Santa Cruz, CA, 95064, USA

Introduction: Tharsis is a vast volcanic plateau located at low latitudes in the western hemisphere of Mars. In this area, there are four large shield volcanoes: Arsia Mons, Pavonis Mons, Ascraeus Mons and the tallest volcano in Solar System, Olympus Mons. Images and topography show rich volcanic morphologies, numerous impact craters of different sizes and traces of extinct ice sheets on the gentle slopes of the volcanoes. This area has high albedo (with some variations) and uniformly low thermal inertia. Recently, high-resolution images obtained by camera HiRISE [1] onboard MRO revealed that the surface in this region is covered by pervasive decameter-scale aeolian bedforms [2] of specific morphology (Fig. 1). These bedforms were argued to be presently active [2]. We noted that in many locations these deposits bear populations of superposed small (D < ~20 m) fresh impact craters, which indicates that the deposits are currently inactive or the rate of their activity is extremely low, but was much higher in some geologically recent past. We are collecting a database of small craters in HiRISE images on slopes of the volcanoes to get an insight into changes of the wind regime for the last million years. Here we report preliminary results of this survey.

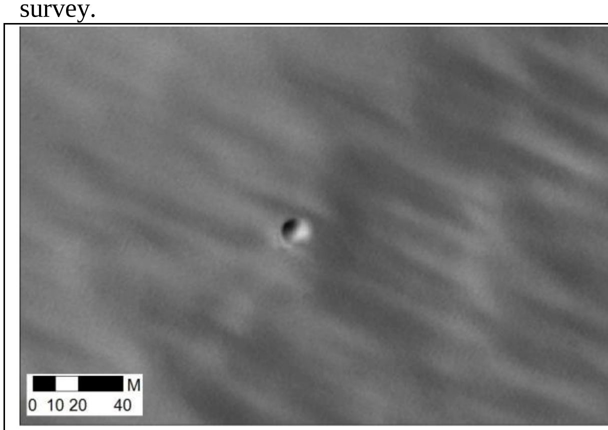

Fig. 1 Aeolian bedforms and a superposed impact crater on SW flank of Pavonis Mons; from HiRISE image PSP_009646_1795.

Source data and method: In our work we used HiRISE images [1] obtained at full resolution and map-projected at 0.25 m/pix. We discarded images with low signal-to-noise ratio (apparently due to clouds or hazes). We also excluded several images, where the bedform-forming layer is not continuous and the gaps in it reveal densely cratered substrate. We excluded steeply inclined parts of the imaged scenes (such as Olympus Mons scarps, caldera walls, etc.). For scenes with obvious geological boundaries (like lower and upper calderas of Olympus Mons), we considered the units separately.

We searched images for fresh small craters superposed over the aeolian bedforms. We registered all such craters larger than 3 m using CraterTools [3] in ArcGIS. Some craters form clusters resulted from meteoroid breakup in the atmosphere [4]. For our purposes such clusters should be tread as a single event. We used an algorithm for automated cluster identification [5] or identified them manually, and then combined into a single effective crater [4]. We also note morphological peculiarities of each studied scene.

Morphological observations: We confirm observations from [2] that the specific aeolian bedforms are pervasive, however, we saw a few images where the aeolian material was thin and patchy. On the volcano flanks the wind direction inferred from the bedform morphology is downslope, in general accordance with the katabatic wind direction predictions [6]. Many craters have pristine appearance, however, radial ejecta and dark blast zones seen on newly formed craters of the same size [7,8] are extremely rare. Some craters are noticeably modified by winds; their inferred directions usually are the same as those inferred from the bedform morphology.

Crater populations in the surveyed images have different crater density and different shapes of the size-frequency distributions (SFD). For example, craters at Olympus Mons summit have steep SFD ($\propto D^{-3}$) (Fig. 2) consistent with production function for small craters [5,9]. This means that active movement of sand ceased 50 – 100 ka ago (absolute ages are very uncertain), and craters have been accumulating since that. Two examples from Pavonis Mons (Fig. 2) show gentler SFD ($\propto D^{-2}$) indicating that the formation of craters and their obliteration are balance, and life span of a crater is proportional to its diameter D. Obliteration in the caldera is a factor of ~3.5 slower than on the SW flank at a similar elevation.

The latter site (Fig. 3) illustrates the boundary between different crater modification regimes. The difference in surface brightness in this image indicates the presence or absence of a thin veneer of dust settling from the atmosphere. In the bright NE corner of the image the veneer has been untouched by the winds for at least several Martian years. Within the dark wind streaks, disruption of the thin dust layer had occurred once or a few times during 1 - 2 martian years before the image was obtained. It was associated with the strongest gusts of wind blowing from the northeast, which initiated saltation, formed the streaks, but did not cause significant damage to the craters. The SW corner of the image has a much lower density of craters, and there are no craters smaller than 5m. There, wind exceeds the saltation threshold more often; this prevents formation of the bright dust veneer and destroys craters faster than they form.

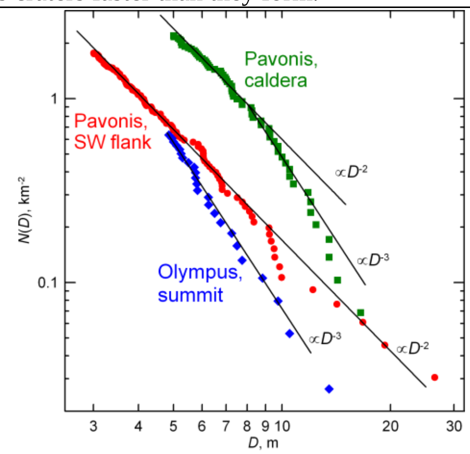

Fig. 2. Examples of cumulative size-frequency distributions of superposed craters: "Pavonis caldera" PSP_005295_1815; "Pavonis SW flank", PSP_009646_1795, the area shown in Fig. 3; "Olympus summit", PSP_008460_1980.

Conclusions: (1) In some areas within Tharsis the aeolian bedforms are active, while in the others they are inactive. Crater retention time scales vary in a wide range. (2) There are indications of the change in wind regimes and/or atmospheric pressure at ~100 ka time scale. (3) Extensive survey of small crater populations is promising for understanding the present and past wind regimes.

Acknowledgements: The work was partly supported by the Russian Federation Federal Program contract № 14.B37.21.0914.

References:

[1] McEwen A.S. et al. (2007) *JGR 112*, E05S02.
[2] Bridges N. T. et al. (2010) *Icarus 205*, 165-182.
[3] Kneissl T. et al. (2011) *PSS 59*, 1243–1254.
[4] Ivanov B. et al. (2009) *LPSC XL*, 1410.
[5] Kreslavsky M. (2008) *EPSC2008*-A-00237.
[6] Spiga A. et al. (2011) *Icarus 212*, 504-519.
[7] Malin M. C. et al. (2006) *Science 314*, 1573-1577.
[8] Daubar I. et al. (2011) *LPSC XLII*, 2232.
[9] Hartmann W. K. et al (2010) *Icarus 208*, 621-635.

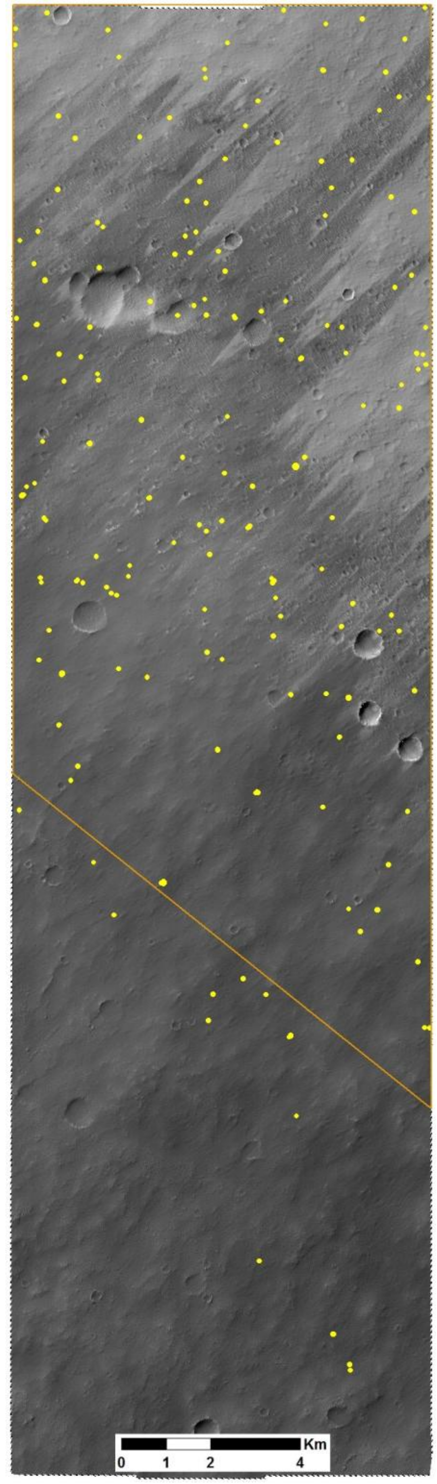

Fig. 3. Reduced-resolution HiRISE image PSP_009646_1795. All features seen at this resolution are uniformly covered with aeolian bedforms. Dots show locations of superposed craters (like shown in Fig. 1). Outlined is the area of "Pavonis NW flank" crater population in Fig. 2.