LANDSLIDE-GENERATED TSUNAMI ON MARS? F. V. De Blasio[1] Dept. of Earth and Environmental Sciences, Università degli Studi di Milano Bicocca, Italy, e-mail: fabio.deblasio@unimib.it

Introduction: The aureole deposit on Mars (Fig. 1) consists of at least 10 rock-avalanche remnants (each about 10^4-10^5 km^3 in volume or more) encircling the whole volcanic edifice of Olympus Mons [1-4]. Runout distances are in some cases amazingly longer than 500 km, while the H/L ratio between the fall height H and the runout length L of about 0.02 or less indicates extremely low friction met by the rock avalanches [2,4].

The western (W) aureole is possibly the largest (volume on the order 10^6 km^3) widest (>100°) and longest (runout >650 km) landslide not only in the surroundings of Olympus Mons, but in the whole solar system [1,2]; Fig. 1. According to ref. [4], it was the result of the collapse of one single sector of the Olympus Mons flank.

While the north-western portion of the W aureole crossed the flat plains of Amazonis Planitia after 550 km of travel, the northward part struck against the wide Acheron ridge (also called "Acheron Dorsum"). Thereafter, it continued travelling uphill on the ridge for further 50-80 km, before coming to rest. The cross section in Fig. 1 (bottom) shows the main W aureole landslide body and the front resting on Acheron ridge.

Beyond the terminus of the W aureole landslide, a long veneer of clastic deposits on Acheron Dorsum has been documented [4,5]. Termed in ref. [5] "Frontal Aureole Deposits" (FAD), such units are interpreted as hardened wet sheets of clastic deposits thrust by the fast-travelling front of the aureole.

The FAD deposits: A CTX image of one portion of the FAD deposits is shown in Fig. 2. Based on the morphology, FAD can be distinguished into the two sub-units: a smooth featureless unit in continuation with the W aureole terminus, followed by a multi-lobate deposit whose lobes are oriented parallel to the original aureole flow direction. The presence of craters semi-filled by such FAD clastic units shows that the Hesperian age attributed by Tanaka et al. (2014) [6] to this unit (the rest of Acheron being late Noachian, and thus older in age) is partly due to the presence of the FAD. In other words, this part of Acheron appears to be rejuvenated by the wet sheets of the FAD, which blanketed small craters. A transitional age between late Hesperian to Amazonian (3 Ga) results from crater counting, but this age includes craters that were likely formed before the FAD, and were only partly covered by the deposits. Thus, the age of FAD is thus more likely Amazonian.

Interpretation of the FAD deposits: As mentioned, the explanation proposed here for these clastic deposits is that water-rich sediments were thrust by the front of the W aureole when travelling on Acheron ridge. Numerical simulations and analytical estimates show that the resulting wave distance due to impact with a landslide with the properties of the W aureole on Acheron Fossae is on the order of the observed FAD deposit lengths. Possible explanations for wet soil are: i) a huge tsunami-like wave similar to those documented on Earth when a large landslides plunges onto a water fjord, lake, or sea. In fact, the W aureole fell onto an area proposed for the Martian ocean, but the existence of water into such late times is perhaps to most researchers debatable; ii) water ponds located in the area, or: iii) ice that was frictionally melted by the flow of the landslide.

Conclusions: If the tsunami scenario is correct, it follows that at least in the area of Amazonis-Arcadia Planitiae, the Martian ocean persisted at the time of the collapse of the W aureole Olympus Mons landslide, i.e., early Amazonian. As mentioned, an alternate explanation is that ice or smaller water ponds may have provided the liquid water with which the Martian soil mixed before beigh thrust by the W aureole landslide and finally being deposited as FAD deposit.

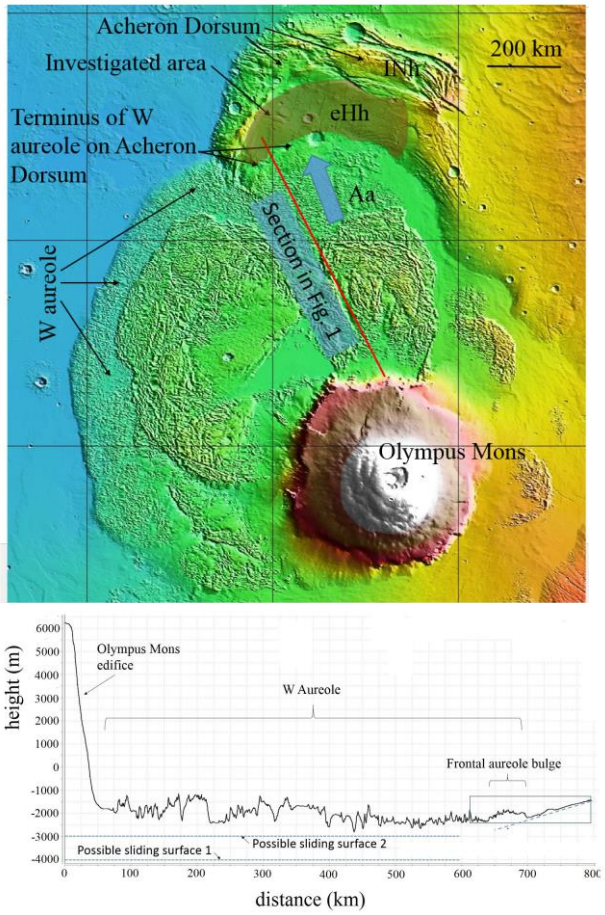

Figure 1. Top: area investigated roughly corresponding to the Hesperian area marked as "eHh" in ref. [6]. Colorized MOLA.
Bottom: MOLA section through the red line crossing the Olympus Mons edifice, the W aureole, and Acheron ridge. Note that the frontal landslide bulge rests on the Acheron ridge.

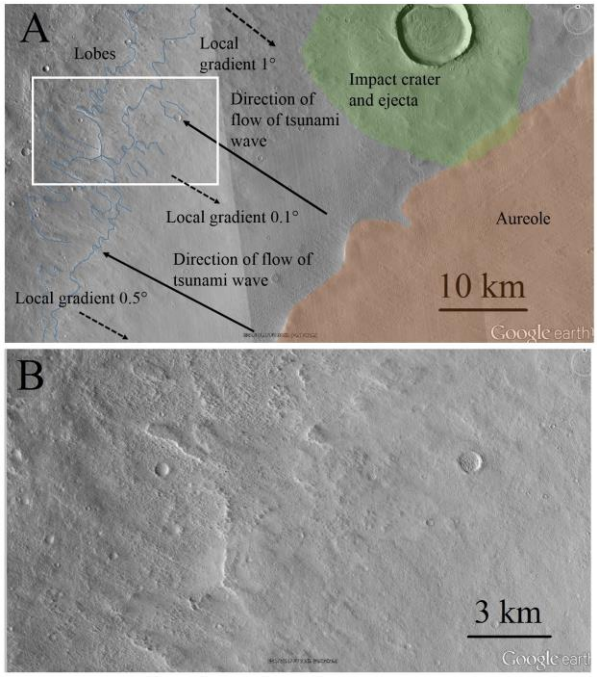

Figure 2 A: portion of the FAD deposits with indicated the local gradients and the outline of some lobes. B: uninterpreted, magnified image of the white area. CTX. The lobes are parallel to the axis crossing the Olympus Mons edifice, which identifies the flow direction that the W aureole must have had during its flow. The lobe orientation along the flow direction of the W aureole landslide is a strong argument in favor of a genetic relationship between FAD and aureole. The numerous large impact craters like the one in the scene allow attributing to Acheron ridge a Noachian age [6], but the FAD rejuvenated southern Acheron [5].

References: [1] McGovern, P.J., Smith, J.R., Morgan, J.K., Bulmer, M.H., 2004. *J. Geoph. Res*. v. 109, E08008. [2] De Blasio, F.V. (2011), *EPSL 312*, 126-139. [3] Mouginis-Mark P. (2017) *Chemie der Erde*,https://doi.org/10.1016/j.chemer.2017.11.006[4]. De Blasio, F.V. (2018*) Icarus 30*2, 44-61. [5] F.V. De Blasio, subm. To *Planetary and Space Scienc*e. [6] K. Tanaka et al., 2014. Geologic Map of Mars. USGS Scientific investigations Map 3292.