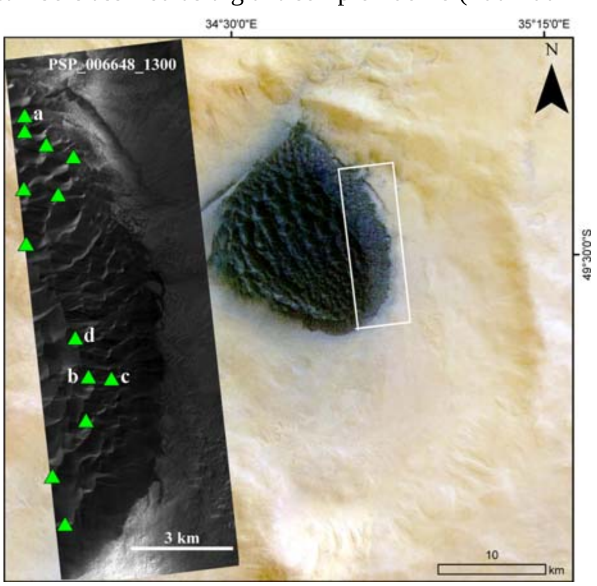
DEFROSTING PROCESSES ON DARK DUNES: NEW INSIGHTS FROM HIRISE IMAGES AT NOACHIS AND AONIA TERRAE, MARS. G. Di Achille[1], S. Silvestro[1], and G. G. Ori[1,2], [1]International Research School of Planetary Sciences, Università "G. D'Annunzio", Pescara, Italy; [2]Ibn Battuta Centre, Universite Cady Ayyad, Marrakech, Morocco. (gadiachi@irsps.unich.it)

Introduction: Morphological surveys of Martian ergs have recently revealed the occurence of gullies and scars on dark dune slopes [1-7]. They have been classified according to their morphology [1,2] and interpreted to be the results either of regular dry avalanching or fluid erosion and transport [1-7]. In particular, *Bourke* interpreted alluvial-like lobate deposits, developed at the base of dune slip faces, as possible evidence for niveo-aeolian and denivation processes [6, 7]. However, the origin of these features is often still enigmatic and likely related to the peculiar environmental conditions of Mars in relation to the behavior of volatiles and thermophysical properties of sand. Here, we present new HiRISE observations (Fig. 1 and 2) of dunes belonging to dark ergs formed within two unnamed craters [8]. Our survey identified unusual meter-scale circular depressions at the termini of grooves and gullies (Fig. 1 and 2). The latter features are interpreted to be the results of a combination of possibly overlapping processes, occurring during the seasonal defrosting at this latitude region. These likely involve frost vaporization, reprecipitation, snowball-like downslope rolling of frost/sand aggregates, glacial-like creep sustained by ephemeral liquid flow, and terminal sublimation at the base of dunes.

Observations: Studied ergs are located within two unnamed craters in Noachis (48-km-diameter; Fig. 1) and Aonia (10-km-diameter; Fig. 2) Terrae, respectively. The first covers an area of about 210.7 km^2 and can be classified as a giant complex dome (200-400 m



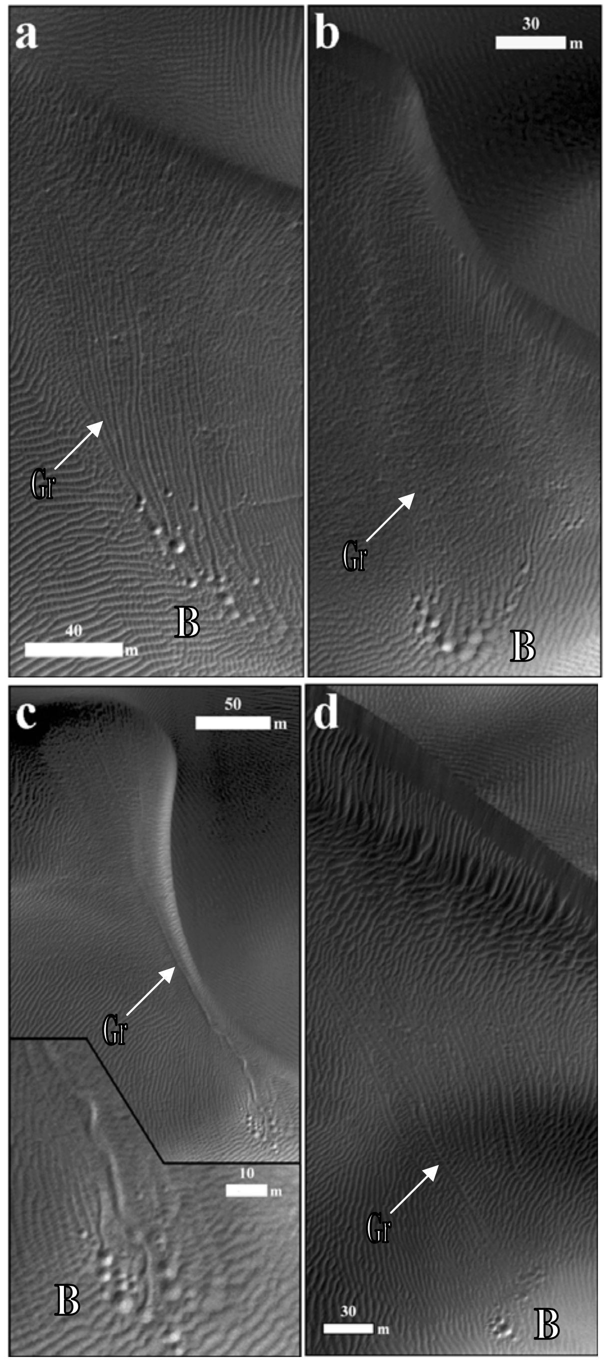


Figure 1. (left) Overview of the studied erg in Noachis Terra: HRSC color mosaic showing the dark erg with superimposed footprint of PSP_006648_1300 HiRISE image shown as inset. Green triangles indicate possible defrosting features. (above: a, b, c, d) Close-up from HiRISE image (see overview for location; **Gr** indicate grooves; **B** the bowl-shaped meter-scale depressions).

high), comparable to terrestrial examples occuring in the northern Saudi Arabia [9]. The second erg covers an area of about 10.8 km^2 and is mainly composed of barchan dunes with slipfaces reflecting dominant winds from northeast (Fig. 2).

Grooves, gullies and small circular depressions. HiRISE images of both the above described ergs show extensive occurrence of shallow grooves (**Gr**) and gullies (**Gu**) that occur mostly along the SE-facing dune slopes and terminate with bowl-shaped shallow depressions (**B**) (Fig. 1 and 2). However, **Gr** and **Gu** appear rather different from previously recognized gullies on Martian dunes (e.g. Russel crater [1]), first of all, for the previously unidentified presence of **B** features at their termini, but also for the lack of levees and terminal debris aprons, and for their lower depth. **Gr** and **Gu** are a few meters wide, start from dune crests and extend downslope of dune slipfaces with length ranging from tens up to a few hundreds meters (Fig. 1 and 2). **Gr** are generally arranged in series of low-sinuosity and parallel lineations (Fig. 1a, b, d). Occasionally the lineations originate from alcove-like crenulations along the dune crests, then converge at mid-slope into a main groove, which wanes downslope into a series of **B** features (Fig. 1c). **Gu** have usually same dimensions with respect to **Gr** but are deeper and wiggler than grooves (Fig. 2b, c). Like **Gr**, they also start from dunes crests, however, their upslope portions often show low-order dendritic patterns and convergence of several lineations into a single gully. Bowl-shaped features (**B**) usually occur as small clusters at the base of dune slipfaces, or at local topographic lows surrounded by dune crests, in association with the sharp terminations of grooves and gullies (Fig. 1 and 2). **B** diameters range from tens of centimeters up to a few meters and never exceed 10 m. In some cases the diameters of the small circular depressions appear to be proportional to the length of the associated grooves (Fig. 2b).

Discussion and conclusion: On this base, we interpret the formation of **Gr**, **Gu** and **B** at their termini to be the results of seasonal defrosting occurring along the dune slipfaces. In particular, we hypothesize that the spring/summer defrosting of the dune slopes could explain the formation of the observed morphologies without involving a significant role of fluid erosion and transport. In fact, shallow grooves and gullies, shown by HiRISE images, display low sinuosity, lack of levees and distributary deposits at their mouths, and the presence of bowl-shaped depressions, which we interpret as resulting from the sublimation of meter-scale aggregates of CO_2-H_2O frost and sand. These could have arrived at the base of the dunes mainly through snowball-like rolling and glacial-like creep. The latter might have been sustained by alternate evaporation and reprecipitation of volatiles during the downslope movement, possibly also enhanced by the presence of an ephemeral basal liquid fraction, especially for the **Gu** features (Fig. 2). In conclusion, **Gr**, **Gu**, and **B** could have formed due to an almost “dry” mechanism and represent remnants of transport of frost along dune slopes and its terminal basal sublimation. Therefore, preliminary HiRISE investigation of Martian dunes likely suggests that defrosting processes might involve less amount of liquid water than previously thought [e.g. 1, 2, 6, 7]. Further observations and repeated surveys of regions affected by seasonal defrosting could help to test this perspective and asses the role of the liquid component during Martian defrosting processes.

References: [1] Reiss D. and Jaumann R. (2003) *GRL*, 30, 1321. [2] Reiss et al. (2007) *LPSC XXXVIII*, 1993. [3] Mangold N. et al. (2003) *JGR*., 108, 5027. [4] Malin M. C. and Edgett K. S. (2001) *JGR*, 106. [5] Edgett K. S. and Malin M. C. (2000) *JGR*, 105, [6] M. C. Bourke, (2004) *Eos Trans*., 85, pp. Abstract P21B-01. [7] Bourke M. C. (2005) *LPS XXXVI*, 2373. [8] S. Silvestro S. and G. G. Ori, *this volume*. [9] McKee E. D. (1978) *USGS Prof. Paper*, 1052. [10] Malin M. C. and Edgett K. S. (2000) *LPSC XXXI*, 1056. [11] Kossacki K. J. and Kopystinsky J. (2004) *Icarus*, 168.

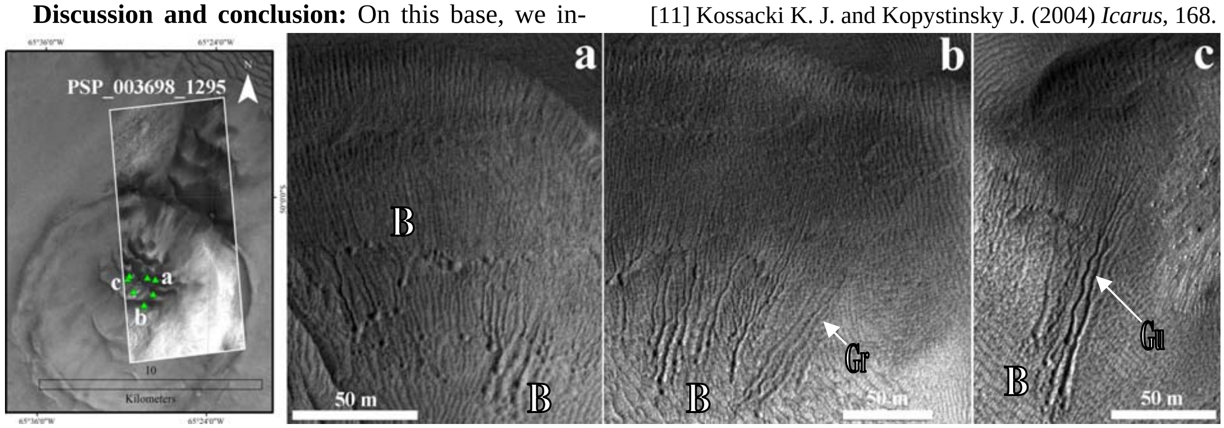


Figure 2. (left) Overview of the studied erg in Aonia Terra: HRSC image of the erg with superimposed PSP_003698_1295 HiRISE image. Green triangles indicate possible defrosting features. (a, b, c) Close-up from HiRISE image (see overview for location; **Gr** indicate grooves; **Gu** indicate gullies; **B** the bowl-shaped meter-scale depressions).