

POSSIBLE SLOW PERIGLACIAL MASS WASTING ON INTERIOR CRATER WALLS ON SOUTHERN MARS. A. Johnsson¹, D. Reiss², E. Hauber³, H. Hiesinger². ¹Department of Earth Sciences, University of Gothenburg, Sweden (andreasj@gvc.gu.se). ²Institut für Planetologie, WWU, Münster, Germany. ³Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt, Berlin, Germany

Introduction: Small-scale lobes (SSL) are enigmatic arcuate landforms on interior crater walls on Mars. SSL's consist of a lobe front (riser) which typically is a meter to a few meters in height and a tread surface. SSL's occur in groups and often, but not always, display overlapping of individual lobes. They range in width from tens to hundreds of meters (Fig. 1). Risers often display a concentration of clasts in contrast to the relatively clast-free tread surface. Lobes with no visible clasts at the risers still have well defined lobe fronts. SSL's are strikingly similar in morphology to solifluction lobes on Earth [1].

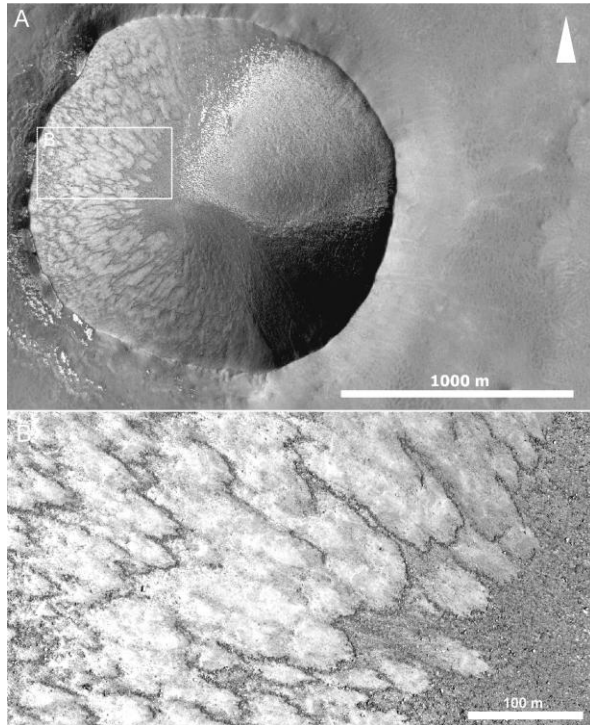


Figure 1. (A) HiRISE image showing an example of high-latitude small-scale lobes on the northern hemisphere, Mars. (B) Lobes display a well-defined front with clasts and a relatively clast free tread surface. Image credit: NASA/JPL/University of Arizona.

In Earth's permafrost regions, solifluction lobes are strong indicators of past and present freeze-thaw activity (Fig. 2). Terrestrial periglacial solifluction lobes are formed by frost creep (combination of repeated frost heave and thaw consolidation) and gelifluction (visco-

plastic deformation of near saturated soil) in the active layer on top of the permafrost table [1].

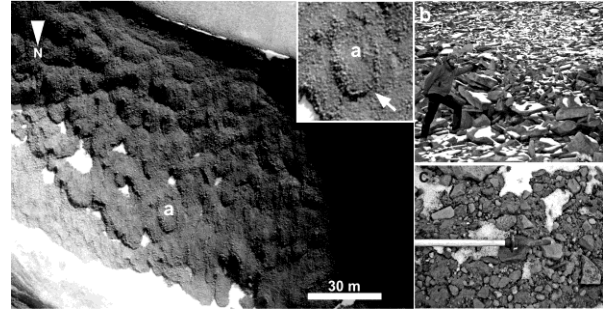


Figure 2. (A) Examples of sorted lobes on a north-facing slope in Adventdalen, Svalbard, identified by the HRSC-AX instrument. A clastic border is clearly distinguished in the inset image. (B) Close up of 1.5 m high riser with front-clasts (person for scale). (C) Tread surface with clasts and a fine supporting matrix. Tip of walking stick for scale.

On Mars, SSL's have been studied in detail at the northern hemisphere (Fig. 1), where they are widely distributed at high latitudes between 59°N and 80°N [2]. SSL's are proposed to represent freeze-thaw activity late in Martian climate history [3, 4, and 5]. SSL's on Mars broadly occur as two types: (1) Sorted or clast-banked lobes which have a concentration of clasts at the riser, while the tread surface is relatively clast free. (2) Non-sorted or smooth-textured lobes with no visible clasts at the riser. Both types occur, in most cases, in close proximity to gullies and polygonal terrain. Previous results from morphometric analysis of the northern SSL's are in agreement with their terrestrial counterparts [2] (Fig. 3). SSL's differ from permafrost creep (i.e. rock glaciers) in having low fronts, decimeters to a few meters (~5 m) in height. They lack compression ridges and furrows and are not confined to topographic niches (i.e. valley confinement). The presence of small-scale lobes raises the question whether they have formed by a warmer-than-thought-climate, or by the influence of soil salts (i.e. perchlorates) under sub-freezing conditions [4].

Though there is an increasing number of studies pointing to a freeze-thaw process their origin are still not firmly determined. This study aims to determine their distribution on the SH and answer the question if they show the same bimodal distribution as other landforms such as gullies and polygons. Does the SH SLL's show

the same close spatial association to gullies and polygons in the south?

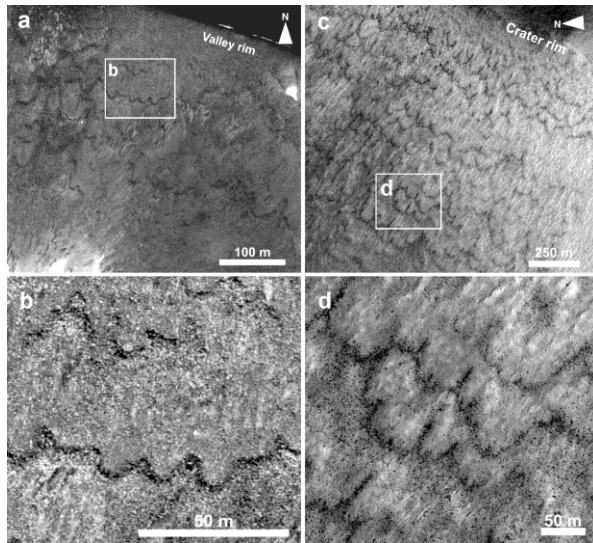


Figure 3. (A) HRSC-AX overview of sorted lobes on 20 slopes on the upper portion of Adventdalen valley, Svalbard. (B) Detailed view of clasts that form arcuate bands. (C) HiRISE image PSP_008141_2440 of sorted lobes on 20 sloping interior crater wall, Mars. (D) Close up of sorted lobes on Mars with clasts between decimeters to meter in size. Image credit: NASA/JPL/UoA.

Data and method: In this study we used images obtained by the High Resolution Imaging Science Experiment (HiRISE) with a resolution of ~ 25 cm/pxl. All HiRISE images from 2007 to 2013 have been compiled from the PDS Geosciences Node *Mars Orbital Data Explorer* (<http://ode.rsl.wustl.edu/mars/index.aspx>). Data has been catalogued in an Excel. HiRISE images have been processed using ISIS3 software and analyses have been done in ArcGIS v. 10.1.

Observations: Observations suggest that SSL's are primarily found in relatively pristine craters in the southern hemisphere. Compared to the northern high-latitude counterparts they are found more equatorward, with observations as low as $\sim 40^\circ$ S. The majority occur in close proximity to gullies and polygonal patterns (Fig. 4A). Well-defined examples show roughly similar plan-form morphology, with overlapping lobe fronts (Fig. 4B). In contrast to the northern bound SSL's these have shorter tread lengths and lobes are less wide. Moreover, some lobes display a stripe-like pattern of darker and brighter bands which consistently follow the slope gradient. SH SLL's occur adjacent and within alcove areas and in close proximity to fresh-looking braided gully channels.

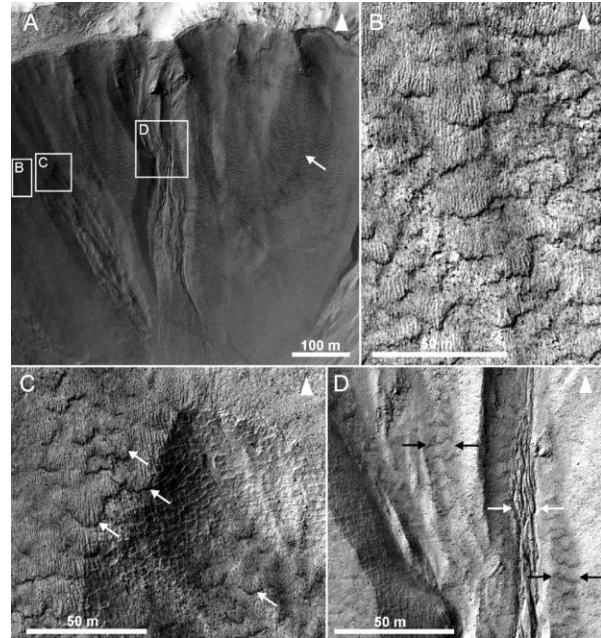


Figure 4. Example of small-scale lobes from a southern mid-latitude crater, Mars. (A) Overview of crater slope with fresh-appearing braided gullies. White arrow shows the location of additional patches of lobes. (B) Well-defined lobes close to gully alcove. Note the striped pattern on lobe treads. On Earth striped patterns are associated with additional freeze-thaw processes resulting in sorted stripes. (C) Lobes on the rim of gully alcove (upper white arrows). Note that lobes are seen within the alcove as well (lower white arrow). (D) Braided gully channel (white arrows) and proximate lobes (black arrows). Image credit: NASA/JPL/University of Arizona.

Summary: To date more than six hundred HiRISE images have been investigated for small-scale lobes in Mars' southern hemisphere. Early results indicate that the small-scale lobes are distributed more equatorward than in the north. Morphometry and morphology suggest that they are distinct from permafrost creep. The project is on-going and more work is required to firmly establish their distribution and their association to gullies and polygonal terrain. Though landforms indicative of freeze-thaw activity may be rare on flat terrain on Mars, there is growing evidence that freeze-thaw conditions may have been met on mid-and-high latitude slopes.

References: [1] Matsuoka, 2001 [2] Johnsson et al., 2012. *Icarus* 218. [3] Gallagher et al., 2011. *Icarus* 211 (1). [4] Balme et al., 2013. *Prog. Phys. Geogr.* 1-36.

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