EVIDENCE FOR SLOW PERIGLACIAL MASS WASTING IN THE SOUTHERN MID-LATITUDES, MARS. A. Johnsson[1], D. Reiss[2], S. Conway[3], E. Hauber[4], H, Hiesinger[2]. [1]Department of Earth Sciences, University of Gothenburg, Sweden, (Box 460, andreasj@gvc.gu.se). [2]Institut für Planetologie, WWU, Münster, Germany. [4]Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Berlin, Germany. [3]The Open University, Walton Hall, Milton Keyes, UK.

Introduction: Small-scale lobate landforms on crater walls and hillsides have been cataloged in the southern mid-latitudes on Mars. These lobate features show striking morphological resemblance to solifluction lobes on Earth and are typically located in a geomorphologic context associated with thermal contraction polygons and gullies. Previously, youthful small-scale lobes have been reported only in the northern hemisphere where they have been suggested to indicate freeze-thaw activity by several authors [1,2,3,4,5]. By implication this suggests active-layer formation and transient liquid water close to the surface at some time in the recent past [1]. Our results show that small-scale lobes exist on slopes in the southern hemisphere as well. Particularly well-developed lobes are concentrated in the region south of the Argyre Basin, but youthful and well-preserved lobes are also found elsewhere in the mid latitudes. Small-scale lobes may represent yet another hemispherical bimodal landform controlled by climate such as gullies and polygonal terrain.

This study aims to determine their distribution on the southern hemisphere and explore if there is a genetic linkage to gullies and polygonal terrain.

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 and Context Camera (CTX) images with a resolution of ~6 m/pxl. All HiRISE images from 2007 to 2013 have been compiled from the PDS Geosciences Node Mars Orbital Data Explorer. HiRISE and CTX images have been processed using ISIS3 software and analyses have been done in ArcGIS v. 10.1.

Solifluction on Earth: In Earth's Arctic permafrost regions solifluction is regarded as the most widespread mass wasting process [6]. Solifluction lobes are strong indicators of past or present freeze-thaw activity (Fig. 1) and may represent a potentially useful source of paleoclimatic information [7]. Terrestrial periglacial solifluction are formed within the active layer that undergoes annual/diurnal thawing and frezing. The main solifluction processes include frost creep, a combination of repeated frost heave and thaw consolidation, and/or gelifluction which is viscoplastic deformation of near saturated soil in the active layer on top of the permafrost table [8].

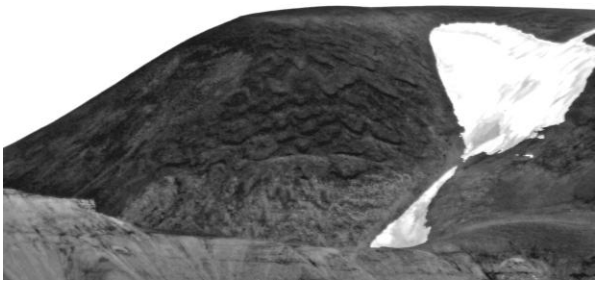

Figure 1. Examples of stone-banked lobes on a south-west-facing slope in Adventdalen, Svalbard.

Small-scale lobes on Mars: On Mars, small-scale lobes have been studied in detail at the northern hemisphere, where they are widely distributed at high latitudes between 59°N and 80°N [2,4]. Small-scale lobes have been proposed to represent freeze-thaw activity in recent Martian climate history [1,2,4]. Small-scale lobes on Mars broadly occur as two types: (1) Clast-banked lobes which have a concentration of clasts at the riser (front), while the tread surface is relatively clast free. (2) Smooth-textured lobes with no visible clasts at the riser. Both types occur, in most but not all cases, in close proximity to gullies and polygonal terrain. Previous results from morphometric analysis of the northern small-scale lobes are in agreement with their terrestrial analogues [4]. Small-scale lobes 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 [5].

Observations: Small-scale lobes are found in well-preserved craters (Fig. 2) and in mountainous regions at the southern hemisphere. Compared to the northern high-latitude counterparts they are found more equatorward, with observations as low as ~40°S. Using HiRISE we have identified 36 candidate sites. In areas where HiRISE images are sparse 37 candidate sites have been identified with CTX.

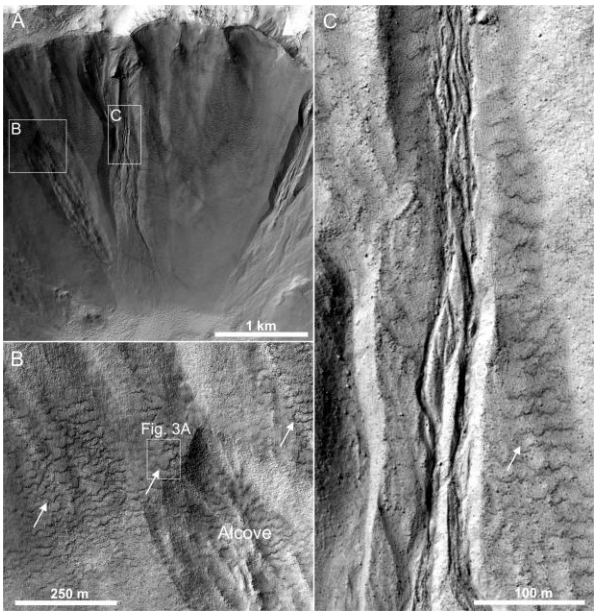

Figure 2. Example of small-scale lobes from a southern mid-latitude crater, Mars. (A) Overview of crater slope with well-preserved braided gullies. (B) Well-defined lobes outside and inside an alcove. (C) Braided gully channel and proximate lobes (white arrow). Image credit: NASA/JPL/University of Arizona.

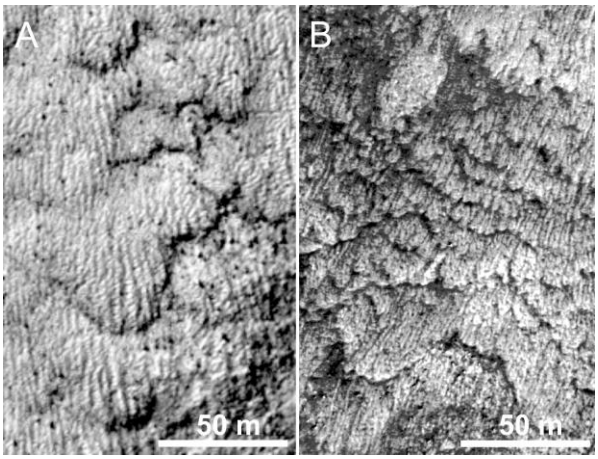

Figure 3. (A) Inset from previous figure. Striped pattern on small-scale lobes, Mars. (B) Solifluction lobes on valley wall with superposing stone stripes, Adventdalen, Svalbard. On Earth striped patterns are associated with freeze-thaw processes resulting in stone stripes.

The majority of small-scale lobes occur in close proximity to gullies and polygonal patterns. Well-defined examples show roughly similar plan-form morphology and overlapping lobe fronts as terrestrial analogues. Moreover, some lobes display a stripe-like pattern of darker and brighter bands which consistently follow the slope gradient. A similar pattern can be seen on terrestrial lobes that are overprinted by stone stripes (Fig. 3). The Charitum Montes region show a particularly high abundance of small-scale lobes. These lobes are well-developed and cover whole mountain slopes (Fig. 4). Interestingly they display an aspect dependence ranging from East to North with the majority at NE. This contrasts to small-scale lobes within crater interiors elsewhere in the mid-latitudes where lobes typically occur on south-facing slopes.

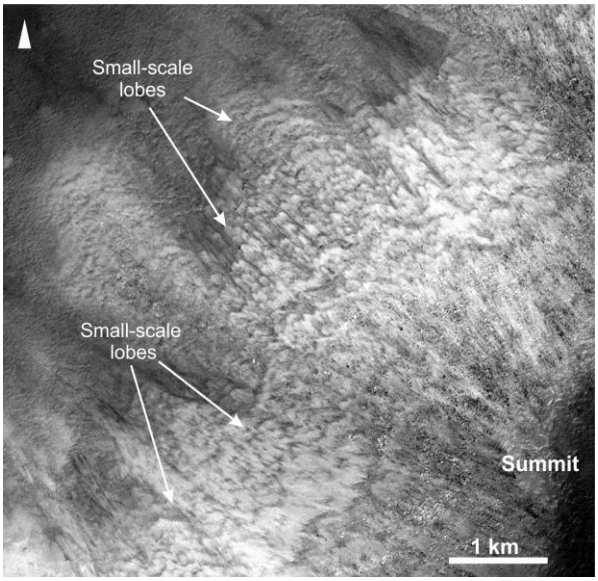

Figure 4. Examples of small-scale lobes from Charitum Montes, Mars. The lobes display the typical NE aspect for this region.

Summary: To date more than 1200 HiRISE and a hundred CTX images have been investigated for small-scale lobes at Mars' southern hemisphere. Preliminary results indicate that the small-scale lobes are shifted more equatorward than in the north. Like the northern counterparts morphometry and morphology suggest that they are distinct from permafrost creep.

Small-scale lobes on interior crater walls and mountain slopes show different aspect dependence. The reason may be formation during different climate scenarios and time scales.

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 on both hemispheres. Thus representing a potentially useful source of paleoclimatic information.

References: [1] Gallagher et al., 2011. Icarus 211 (1). [2] Gallagher and Balme, 2011. GSL 356. [3] Hauber et al., 2011. GSL 354. [4] Johnsson et al., 2012. Icarus 218. [5] Balme et al., 2013. PPG 1-36. [6] French, 2007. 3ed Wiley. [7] Åkerman, 2005. NJG 59. [8] Matsuoka, 2001. ESR 55.

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