Geophysical Research Abstracts
Vol. 12, EGU2010-2821, 2010
EGU General Assembly 2010

Landform assemblages indicative of thaw at high northern latitudes on Mars

Colman Gallagher (1) and Matthew Balme (2)

(1) UCD School of Geography, Planning and Environmental Policy, Newman Building, University College Dublin, Belfield, Dublin 4, Ireland (colman.gallagher@ucd.ie), (2) Dept. of Earth and Environmental Sciences, Open University, Walton Hall, Milton Keynes MK7 6AA, UK (m.r.balme@open,ac.uk)

The presence of nearly pure segregation ice [1] and perchlorates [2] at the Phoenix Landing site, with clean ice also recently confirmed at mid-latitudes of the northern hemisphere [3] suggest that high latitude thaw has occurred extensively, perhaps providing the potential to drive significant, distinctive morphogenesis. We describe the results of a survey of 23 High Resolution Imaging Science Experiment (HiRISE) images covering 337° of longitude between 59°N and 79°N in which such morphogenesis is apparent, confirming that thaw has been a regionally important morphological agent. Sorted clastic circles, stripes and lobes are common forms, especially evident on crater slopes. Also present are braided gully-fan systems, sourced at thermokarst pits, and channels that evolved from enlarged thermal contraction cracks. Not only are these landforms indicative of thaw and flowing liquid but the incision of solifluction lobes by thermokarst gullies demonstrates that thaw has been responsible for polycyclic morphogenesis. This landform assemblage reflects zonally extensive freeze-thaw and liquid-driven processes. Morphogenesis related to thaw and flowing liquid, therefore, is an important component of the high northern landscape of Mars.

On low gradient surfaces of the northern plain outside craters, clastic islands are the typical sorted landform. On low gradient surfaces within craters, the dominant sorted forms are clastic nets and circles. With increasing ground slope, blockfields develop a lineated grain and sorted circles become elongated into downslope-oriented ellipses, garlands (i.e. ellipses open downslope) and stripes. The subtle seguing between clastic stripes and clastic lobes reflects local transitions from supply-limited to transport-limited slope units. Slopes patterned by sorted clastic forms exhibit a range of lobate forms ranging from transverse clastic bars linking stripes, to stone-banked lobes and terraces to texturally fine lobes lacking surface clasts. Clastic stripes, lobes and terraces comprise an assemblage indicative of slope modification by frost creep and gelifluction, requiring liquefaction of the regolith.

The widespread occurrence of fluviatile gullies and braided fans on the inner walls of many high latitude martian craters reflects generation and surface flow of significant quantities of liquid. Commonly, gullies have incised stone banked solifluction lobes, demonstrating that the gullies and the flows of liquid they reflect are either coeval with or postdate the solifluction forms. Hence, locally at least, morphogenesis driven by gelifluction, but perhaps involving minimal thaw, was succeeded by morphogenesis reflecting the action of flowing liquid. Gully evolution reflects both headward extension through the backwearing of thermokarst depressions at the head of gully networks but also by the deepening and widening of existing channels through the development of epigenetic pits and widened longitudinal cracks. While such crack-widening on its own could reflect sublimation, its existence in gullies that have also experienced secondary incision by flows clearly sourced at single pits demonstrates the thermokarst nature of some gully systems. Ground-ice thaw was the fundamental morphogenetic driver of these systems, resulting in the extended production and action of liquids, first through solifluction, then fluvioperiglacial action.

Landforms associated with freeze-thaw cryoturbation, liquefaction and surface liquid flows are widespread at high northern latitudes on Mars, demonstrating that thaw has played not only a more important role than previously envisaged but a dominant role in shaping the geomorphology of the high latitudes of Mars. Crater-bound landform assemblages indicative of cryoturbation, frost-creep and gelifluction, superceded by landforms indicative

of flows of surface liquids and surface liquid accumulations suggest that many high latitude crater bottoms have been wet environments. The presence of these landforms across the high northern latitudes of Mars indicates that the regional importance of thaw has been underestimated. This in turn has important implications for the development of better climate models and the search for life on Mars.

[1] Smith P.H. et al. (2009) Science, 325, 58-61. [2] Hecht M.H. (2009) Science, 325, 64-67. [3] Byrne S. et al. (2009) Science, 325, 1674-1676.