Quantitive analysis of gully long profiles on Earth and Mars

Conference or Workshop Item

Geophysical Research Abstracts
Vol. 12, EGU2010-9889, 2010
EGU General Assembly 2010

Quantitive analysis of gully long profiles on Earth and Mars

Susan Conway (1,2), Matthew Balme (1), John Murray (1), and Martin Towner (3)

(1) Department of Earth and Environmental Sciences, Open University, United Kingdom (s.j.conway.00@cantab.net), (2) Laboratoire de Planétologie et Géodynamique de Nantes URM-CNRS 6112, Université de Nantes, Nantes, France, (3) Impacts and Astromaterials Research Centre, Department of Earth Science and Engineering, Imperial College London, United Kingdom

We investigated the scale, slope and curvature properties of gully long profiles on Earth and Mars to ascertain whether gullies on Mars are formed by alluvial and/or debris flow processes. During this investigation we also compared generic slope profiles on Mars to those with gullies.

To perform these analyses we used digital elevation models (DEMs) for Earth, the majority of which were derived from $\sim$ 1 m resolution LiDAR data from the UK's NERC ARSF and the USA's NSF NCALM. For Mars we used a technique developed by Kreslavsky [1] to extract elevation data from pairs of RDR HiRISE images. We successfully validated this technique by comparing its results to those from HiRISE DEMs made using automated stereo photogrammetry techniques [2].

We found that gullies produced by debris flow have properties distinct from those formed by alluvial processes on Earth. In general, debris flow gullies are less concave than alluvial gullies, have a basal concavity and have higher slopes than alluvial gullies. We then compared our results from Earth to the gully profiles on Mars and found that properties of gullies on Mars overlap those of both debris flow and alluvial gullies on Earth, however, gullies on Mars are slightly more similar to terrestrial debris flow gullies. In addition gully long profiles on Mars are distinct from generic slope profiles on Mars with some overlap – this shows that the gully forming process has a marked morphological impact on martian slopes.

Our observed latitudinal patterns in gully formation are in agreement with previous investigations [3, 4], with greater numbers of gullies found at $\sim$40° and $\sim$70° latitude north and south. In addition we found that gullies at mid-latitudes are more densely packed and occur across whole slope sections (rather than isolated patches), suggesting this region has preferential conditions for gully formation. Our morphological comparison with gullies on Earth suggests that the formation process shifts from pure water flow at high latitudes to debris flow processes at lower latitudes. We find more mature gully profiles on pole-facing slopes. These latitudinal and orientation observations support the Costard [5] climate-based model for gully formation, rather than formation from an underground aquifer.

[1] Kreslavsky M. A. (2008) Workshop on Martian Gullies 2008, #1303, p.54-55. [2] Kirk R. L. et al. (2008) J. Geophys. Res. Planets, 113, doi:10.1029/2007JE003000.[3] Balme M. et al. (2006) J. Geophys. Res.-Planets, 111, doi:10.1029/2005JE002607. [4] Kneissl T. et al. (2009) Earth. Planet. Sci. Lett., In Press. [5] Costard F. et al. (2002) Science, 295, 110-113.