EPSC Abstracts
Vol. 12, EPSC2018-339-1, 2018
European Planetary Science Congress 2018

Lobate features on Mars: a morphological and comparative study with dry and wet terrestrial analogues

Renaldo Gastineau (1), Susan Conway (1), Andreas Johnsson (2), Nicolas Mangold (1) and Peter M. Grindrod (3)
(1) CNRS, Laboratoire de Planétologie et Géodynamique, Nantes, France. (renaldo.gastineau@gmail.com)
(2) Department of Earth Sciences, University of Gothenburg, Gothenburg, Sweden.
(3) Department of Earth Sciences, The Natural History Museum, London, UK.

Abstract

If the small-scale lobes observed on Mars (Fig. 1) are the result of solifluction, their existence has important implications for our understanding of recent climate history, the distribution of thaw liquids and its geomorphic effects. We already know that these small-scale lobes are limited to sloping terrains, that they occur in craters which also host gullies and polygonal patterned ground and that they rise decimeters to few meters high [4,6]. In this study, we performed a comparative 3D morphometric analysis of the lobes on Mars and of terrestrial analogues to better understand their formation. We used data from High Resolution Imaging Science Experiment (HiRISE) camera in order to create Digital Terrain Models (DTMs). For the terrestrial analogues, we used DTMs and orthophotos of periglacial and desert environments on Earth.

1. Introduction

Small scale lobes (SSL) on Mars are landforms which have notable morphological similarities with terrestrial solifluction lobes (Fig. 1) [4]. SSL are limited to sloping terrain and mainly observed in the northern hemisphere. The southern hemisphere has more steep slopes [5], so the relative paucity of SSL is not clearly understood, but could be linked to hemispherical differences in surface properties [4]. Mid-latitude SSL have a pole-facing preference whereas high-latitude ones have an equator-facing preference [7].

2. Data and methodology

We used data from the HiRISE camera on the Mars Reconnaissance Orbiter at 25 cm/pixel. Using *Integrated Software for Imagers and Spectrometers (ISIS3)* and *Socet Set 5.6.0*, five DTMs at 1 m/pixel were made from HiRISE stereopairs. Six terrestrial analogues have been included in this study: Svalbard, Iceland, Sweden, Greenland, France and the Atacama Desert. The first five have solifluction lobes formed in periglacial environments and the last is a site where lobate forms are observed despite it being one of the driest places on Earth [2,3].

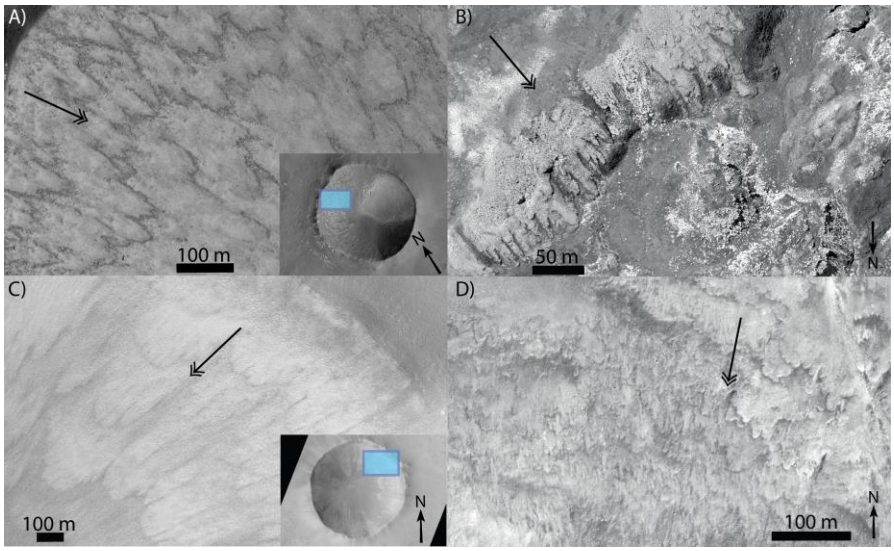

Figure 1: Examples of martian and terrestrial lobes. Double-headed arrows indicate the downslope direction. A) Sorted lobes in the northern hemisphere, in a 1-km-crater. B) Non-sorted lobes at Termignon in the Alps, France. C) Non-sorted lobes in a 4-km-crater. D) Non-sorted lobes located at Tindastóll, Iceland. Credit: NERC ARSF.

Terrestrial data comes from High Resolution Stereo Camera - AX (HRSC-AX), LIght Detection And Ranging (LIDAR), terrestrial scanner and Pléiades satellite imagery. Using *ArcMap 10.4.1*, we digitised the length and width of each lobe. Thus, slope, aspect, elevation or location of lobes along swath profiles could be derived.

3. Observations and results

To date we have analysed 4504 lobes, 1901 SSL on Mars and 2603 solifluction lobes on Earth. On Mars, SSL are observed on slopes ranging from ~10° to 37°, with a mean and median value of 25°. On Earth, solifluction lobes are found on slopes between 0 and 35°, the mean and median value are 14 and 16°, respectively (Fig. 2). For martian SSL, the width/length ratio appears to increase with decreasing slope. The same trend is apparent for the terrestrial solifluction lobes. On Earth, the W/L ratio of solifluction lobes have a maximum of ~15 for almost flat surfaces (Fig. 3). We are presently analysing the lobes from the Atacama Desert.

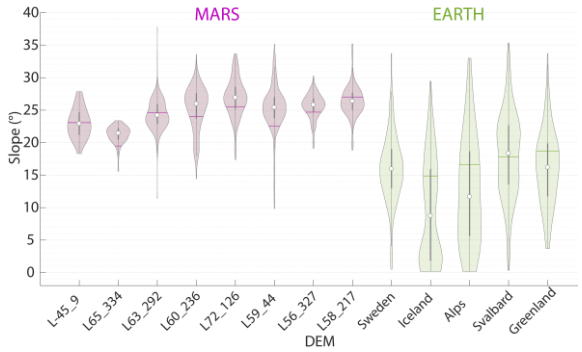

Figure 2: Violin plot of slope of lobes per site. White dots and horizontal lines represents mean and median values, respectively.

4. Discussion and conclusions

Previous work has concluded that SSL on Mars must be a result of solifluction, because they have similar plan-view morphology, slope-side setting and associated landforms to solifluction lobes on Earth [4]. However, our new 3D results shows martian SSL are restricted to high slopes, unlike terrestrial solifluction lobes (Fig. 2). This could be simply due to the lower gravity on Mars (1/3 of Earth gravity) meaning higher slopes are required to initiate creep. The fact that both datasets show the W/L ratio increases with decreasing slope, agrees with observed morphological transitions for solifluction lobes: from tongues to sheets with decreasing slope [e.g., 1]. Ongoing analysis of data from the lobes in the Atacama Desert, where the climate is thought to be more Mars-like will show whether this rare lobe-forming mechanism is a more appropriate analogue for martian SSL than solifluction.

Acknowledgements

This work was supported by the French Space Agency CNES.

References

[1] C.K. Ballantyne and C. Harris. The Periglaciation of Great Britain. CUP Archive, 1994. [2] J. D. Clarke, Geomorphology, vol. 73(1–2), 101–114, 2006. [3] J. J. Owen, et al., Geomorphology, 182, 157–172, 2013. [4] A. Johnsson, et al., Dynamic Mars, 2018. [5] M. Kreslavsky and J. Head, Geophysical Research Letters, 30 (15), 2003. [6] N. Matsuoka, et al., Permafrost and Periglacial Processes, 16(1), 99–113, 2005. [7] E. Nyström, EPSC Abstracts, 9 (EPSC2014-480–2), 2014.

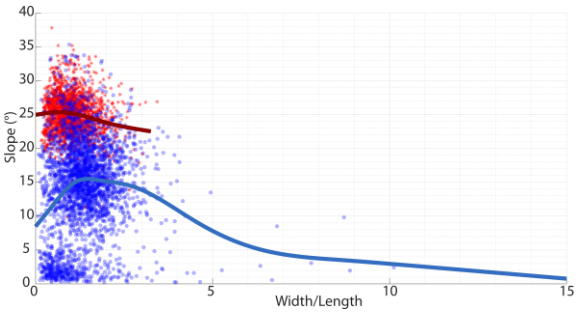

Figure 3: Plot of lobe width/length ratios as a function of mean slope. Blue and red dots represent terrestrial and martian data respectively. A spline for each dataset is also plotted.