Morphometries of eskers on Mars: comparisons to eskers on Earth and implications for sediment-discharge dynamics of subglacial drainage

Conference or Workshop Item

Morphometries of eskers on Mars: comparisons to eskers on Earth and implications for sediment-discharge dynamics of subglacial drainage.

Frances E.G. Butcher[1], Matt R. Balme[1], Colman Gallagher[2,3], Robert D. Storrar[4], Susan J. Conway[5], Neil S. Arnold[6], Stephen R. Lewis[1], Axel Hagermann[7]
[1]School of Physical Sciences, The Open University, Milton Keynes, United Kingdom. [2]UCD School of Geography, University College Dublin, Dublin, Ireland. [3]UCD Earth Institute, University College Dublin, Dublin, Ireland. [4]Department of the Natural and Built Environment, Sheffield Hallam University, Sheffield, Ireland. [5]CNRS, UMR6122, LPG Université de Nantes, Nantes, France. [6]Scott Polar Research Institute, University of Cambridge, Cambridge, United Kingdom. [7]Biological and Environmental Sciences, University of Stirling, Stirling, United Kingdom

Abstract

Mars is a glaciated planet with an extremely cold and hyper-arid climate. It hosts water ice within polar ice caps, ground ice, and thousands of mid-latitude debris-covered glaciers. Until recently, it was widely thought that mid-latitude glaciers on Mars' had been pervasively cold-based since their formation 10s–100s Myr ago.

However, our recent discoveries of eskers associated with ~110–150 Myr old glaciers in the Phlegra Montes [1] and Tempe Terra [2] regions of Mars' northern mid-latitudes indicate that localised wet-based glaciation has occurred during Mars' most recent geological period, possibly driven by locally-elevated geothermal heat flux and strain heating within the glacial ice [1–3]. Eskers are sinuous ridges comprising sediments deposited in glacial meltwater conduits. They are important tools for reconstructing the extent and dynamics of wet-based glaciation on Earth, and have similar potential for Mars.

We used 1–2 m/pixel digital elevation models derived from 25–50 cm/pixel High Resolution Imaging Science Experiment stereo-pair images to measure the planform and 3D morphometries of the mid-latitude Martian eskers, and compare them with the morphometries of Quaternary-aged eskers in Canada [4] and SW Finland [5]. We found that the Martian eskers have remarkably similar lengths, sinuosities and heights to terrestrial eskers, but that the Martian eskers are typically wider and have lower side slopes. Large width-height ratios of the Martian eskers are consistent with our previous measurements of ancient (~3.5 Ga) eskers close to Mars' south pole [6]. These large ratios may arise from differences in either esker degradation state or fundamental glacio-hydrological controls on esker formation between Mars and Earth.

We also used a novel morphometric approach to test evidence for spatio-temporal variations in sediment-discharge dynamics during formation of the Martian esker in Tempe Terra. Our analyses reveal that this esker has a 'stacked' morphology: the crest of a wide, round-crested underlying ridge is superposed by a narrow, sharp-crested to multi-crested ridge. The superposed ridge is aligned with a channel-like depression that incises the underlying ridge. Based on morpho-sedimentary relationships observed along terrestrial eskers [7], we interpret this stacked morphology to represent conduit adjustment as a result of waning meltwater discharge and sediment supply towards the end of the esker-forming drainage episode(s).

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