

# Open Research Online

---

The Open University's repository of research publications and other research outputs

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

Conference or Workshop Item

How to cite:

Butcher, Frances E.G.; Balme, Matthew R.; Gallagher, Colman; Storrar, Robert D.; Conway, Susan J.; Arnold, Neil S.; Lewis, Stephen R. and Hagermann, Axel (2019). Morphometries of eskers on Mars: comparisons to eskers on Earth and implications for sediment-discharge dynamics of subglacial drainage. In: 20th Congress of the International Union for Quaternary Research (INQUA), 25-31 Jul 2019, Dublin, Ireland.

For guidance on citations see [FAQs](#).

© 2019 The Authors

Version: Version of Record

Link(s) to article on publisher's website:  
<http://www.inqua2019.org/>

---

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

---

[oro.open.ac.uk](http://oro.open.ac.uk)

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

Frances E.G. Butcher<sup>1</sup>, Matt R. Balme<sup>1</sup>, Colman Gallagher<sup>2,3</sup>, Robert D. Storrar<sup>4</sup>, Susan J. Conway<sup>5</sup>, Neil S. Arnold<sup>6</sup>, Stephen R. Lewis<sup>1</sup>, Axel Hagermann<sup>7</sup>

<sup>1</sup>School of Physical Sciences, The Open University, Milton Keynes, United Kingdom.

<sup>2</sup>UCD School of Geography, University College Dublin, Dublin, Ireland. <sup>3</sup>UCD Earth

Institute, University College Dublin, Dublin, Ireland. <sup>4</sup>Department of the Natural and

Built Environment, Sheffield Hallam University, Sheffield, Ireland. <sup>5</sup>CNRS, UMR6122,

LPG Université de Nantes, Nantes, France. <sup>6</sup>Scott Polar Research Institute, University

of Cambridge, Cambridge, United Kingdom. <sup>7</sup>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).

This work was funded by STFC grant ST/N50421X/1.

References: [1] Gallagher, C., and Balme, M.R., (2015), *Earth. Planet. Sci. Lett.* 431, 96-109, [2] Butcher, F.E.G., et al. (2017), *J. Geophys. Res. Planets.* 122(12), 2445-2468, [3] Butcher, F.E.G., et al. (2019), This Conference, [4] Storrar, R.D., et al. (2014) *Quat. Sci. Rev.* 105, 1-25, [5] Storrar, R.D., and Jones, A., Unpublished, [6] Butcher, F.E.G., et al. (2016), *Icarus* 275, 65-84, [7] Burke, M.J., et al. (2010) *Geol. Soc. Am. Bull.* 122, 1637-1645.