
URL
https://oro.open.ac.uk/49211/

License
(CC-BY-NC-ND 4.0)Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

Policy
This document has been downloaded from Open Research Online, The Open University's repository of research publications. This version is being made available in accordance with Open Research Online policies available from Open Research Online (ORO) Policies

Versions
If this document is identified as the Author Accepted Manuscript it is the version after peer review but before type setting, copy editing or publisher branding
Morphometric characterisation of eskers associated with an extant mid-latitude glacier on Mars.

Frances E.G. Butcher\(^1\), C. Gallagher\(^2\), N.S. Arnold\(^3\), M.R. Balme\(^1\), S.J. Conway\(^4\), S.R. Lewis\(^1\), A. Hagermann\(^1\)

\(^1\)The Open University, UK (frances.butcher@open.ac.uk), \(^2\)University College Dublin, Ireland, \(^3\)University of Cambridge, UK, \(^4\)CNRS, LPG Nantes, France.

Evidence for basal melting of modern putative debris-covered glaciers (DCGs) on Mars is extremely rare.

- Modern DCGs are likely frozen to their beds, but has this always been the case?
- Gallagher and Balme \cite{Gallagher2015} identified *sinuous ridges* in the foreland of a late-Amazonian-aged (~150 Ma) DCG in Phlegra Montes (Figs 1-3).
- They interpreted these ridges as *young eskers* (Fig 4) – the first of their kind identified in association with a modern DCG on Mars.

![Global topographic context of Phlegra Montes from Mars Orbiter Laser Altimeter (MOLA)](image1)

Eskers are diagnostic of glacial melting.

- Eskers are ridges of sediment deposited by meltwater in ice-walled, typically subglacial drainage conduits, and subsequently exposed by glacier retreat (Fig 4).
- Their morphometry is strongly controlled by the geometry of their parent meltwater conduits, which, in turn, is controlled by hydraulic conditions within them [e.g. 2].

We characterise candidate esker morphometry with new high-resolution 3D data

![Context Camera (CTX) image mosaic of candidate esker in proglacial zone of the parent DCG (lineated valley W)].(c)](image2)

![Schematic of subglacial esker formation](image3)

Plan-view geometry

![System length for the Phlegra Montes candidate esker, Dorsa Argentea (4) and Canadian eskers (5). Boxes - interquartile range, bars - range, dashed lines - median, points - mean.](image4)

- **Plan-view geometry**
  - **Similar length and sinuosity** to Canadian eskers (Fig 7, Table 1).
  - **Similar sinuosity**, to, but shorter than, *ancient* (Early Hesperian) putative eskers near Mars’ south pole (Dorsa Argentea) (Table 1).
  - **Known candidate eskers** on Mars occupy the full range of terrestrial esker lengths (10s m – 100s km).

![Cross-sectional morphometry (Zone 2)](image5)

- **Cross-sectional morphometry** (Zone 2)
  - **Similar heights** to Icelandic eskers (~1 – 14 m [6]) (Fig 8a).
  - **Widths** more similar to terrestrial eskers (~10s m – 2 km [2,6]) than Dorsa Argentea [4] (Fig 8b).
  - **Intermediate side slopes** between Icelandic eskers (~11-22° [6]) and Dorsa Argentea, Mars [4] (Fig 8c).
  - **Lower side slopes** than terrestrial eskers could result from fundamental differences in subglacial hydrology between Earth and Mars, which should be explored further.

![Testing for esker-like response of ridge height to longitudinal bed slope.](image6)

**Ongoing work**

**Phlegra Montes candidate esker morphometry**

- **Tests for esker-like response of ridge height to longitudinal bed slope.**

**NEW DCG-linked candidate esker in a similar graben setting**

- **Abstract #1234**, this conference.
- **Supports the hypothesis** that elevated geothermal heat was a pre-requisite for recent basal melting of mid-latitude glaciers on Mars [1].

**Modelling environmental conditions required for basal melting in Phlegra Montes**

- **Exploring atmospheric temperature and geothermal heat scenarios using the JPL/University of California Ice Sheet System Model (ISSM)** [8].

**References**:


**Acknowledgements**: FEGi is funded by STFC grant ST/N50421X/1 and is grateful for travel support from the 2017 PSI Pierazzo International Student Travel Award. We are grateful to R.D. Storrar for the Canadian esker data.