Morphometric characterisation of eskers associated with an extant mid-latitude glacier on Mars.

Frances E.G. Butcher1, C. Gallagher2, N.S. Arnold3, M.R. Balme1, S.J. Conway4, S.R. Lewis1, A. Hagermann1

1The Open University, UK (frances.butcher@open.ac.uk), 2University College Dublin, Ireland, 3University of Cambridge, UK, 4CNRS, 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 [1] 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.

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 morphology 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 morphology with new high-resolution 3D data

Plan-view geometry

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Cross-sectional morphology (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.

Ongoing work

Phlegra Montes candidate esker morphology

- 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 prerequisite 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].


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Fig 1: Global topographic context of Phlegra Montes from Mars Orbiter Laser Altimeter (MOLA).

Fig 2: Regional topographic context from MOLA. Black arrows show sections of a regional graben, in which the candidate esker is located. Extent in Fig 1.

Fig 3: Context Camera (CTX) image mosaic of candidate esker in proglacial zone of the parent DCG (lineated valley fill). Extent in Fig 2.

Fig 4: Schematic of subglacial esker formation.

Fig 5: New High-resolution Imaging Science Experiment (HiRISE) anaglyph ESP_044804_2130 of (a) the candidate esker complex, and sections of low-albedo clast-rich zone 1 ridge (b) low-albedo zone 3 ridge (c) high-albedo zone 3 ridge crosses a wrinkle ridge.

Fig 6: Methods: (a) oblique view of orthophoto overain on DEM generated from HiRISE images ESP_044316_2130 and ESP_044804_2130, (b) mapped segments and plan-view geometry extraction, (c) cross-sectional profile (location shown in b) and 3D geometry extraction.


Fig 8: (left): (a) height, (b) width, and (c) mean side slope of the Phlegra Montes candidate eskers (Zone 2) and Dorsa Argentea [4]. Boxes – interquartile range, bars – range, dashed lines – median, points – mean.