Morphometric Characterisation of Eskers Associated with an Extant Mid-Latitude Glacier on Mars

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

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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.

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

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.

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 (lined valley III). Extent In Fig 2.

Fig 4: Schematic of subglacial esker formation.

Plan-view geometry

Table 1: Segment and system sinuosity statistics for Phlegra Montes candidate eskers (PM), Dorsa Argentea (DA)\textsuperscript{4}, and Canadian eskers, Earth (CA) \textsuperscript{5}.

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

Cross-sectional morphometry (Zone 2)

- Similar heights to Icelandic eskers (~1 – 14 m \textsuperscript{6}) (Fig 8a).
- Widths more similar to terrestrial eskers (~10s m – 2 km \textsuperscript{2,6}) than Dorsa Argentea [4] (Fig 8b).
- Intermediate side slopes between Icelandic eskers (~11-22° \textsuperscript{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.

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

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 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) \textsuperscript{8}.


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