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 Phlegre 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 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

Plan-view geometry

Table 1: Segment and system sinuosity statistics for Phlegra Montes candidate eskers (PM), Dorsa Argentea (DA)[4], and Canadian eskers, Earth [5].

<table>
<thead>
<tr>
<th>Segments</th>
<th>Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>PM DA CA</td>
</tr>
<tr>
<td>Median</td>
<td>1.00 1.00 1.01 1.01</td>
</tr>
<tr>
<td>Mean</td>
<td>1.02 1.04 1.07 1.07 1.07</td>
</tr>
<tr>
<td>Max</td>
<td>1.22 1.75 2.21 1.25 1.91 2.45</td>
</tr>
</tbody>
</table>

- 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 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 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) [8].

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