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

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Mars' present climate is extremely cold and arid. Until recently, it was widely thought that debris-covered glaciers in Mars' mid-latitudes have been pervasively cold-based since their formation 10s–100s Myr ago. However, we recently discovered eskers associated with ∼110–150 Myr old glaciers in the Phlegra Montes [1] and NW Tempe Terra [2] regions of Mars' northern mid-latitudes. Eskers are sinuous ridges comprising sediments deposited in glacial meltwater conduits. Therefore, eskers associated with existing mid-latitude glaciers on Mars indicate that localised wet-based glaciation did occur during Mars' most recent geological period. Eskers are important tools for reconstructing the nature, extent, and dynamics of wet-based glaciation on Earth, and have similar potential for Mars.

We used 1–2 m/pixel resolution 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 Phlegra Montes and NW Tempe Terra eskers, and compare them with the morphometries of Quaternary-aged eskers in Canada [3] and SW Finland [4]. 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 [5], and may arise from differences in either: esker degradation state, or fundamental glacio-hydrological controls on esker formation between Mars and Earth. Portions of the two Martian eskers with comparable crest morphologies (e.g., sharp- or round-crested) have similar width-height relationships, suggesting that glacio-hydrological processes may exert controls upon the observed relationships between esker morphology and morphometry.

Our morphometric analyses also reveal that the Martian esker in NW Tempe Terra has a 'stacked' morphology: the crest of a wide, round-crested underlying ridge is superposed by a narrow, sharp- to multi-crested ridge. Based on morpho-sedimentary relationships observed along terrestrial eskers [6], we interpret this transition to represent waning sediment supply and meltwater discharge towards the end of the esker-forming drainage episode(s). Direct sedimentary insights into Martian eskers are not yet possible so we emphasise that such inferences should be rigorously grounded in observations of analogous landforms on Earth.

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