Geophysical Research Abstracts
Vol. 21, EGU2019-998, 2019
EGU General Assembly 2019

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.

This work was funded by STFC grant ST/N50421X/1.

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