Evidence for Recent Wet-Based Crater Glaciation in Tempe Terra, Mars.

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Evidence for recent wet-based crater glaciation in Tempe Terra, Mars?

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Evidence for basal melting of putative debris-covered glaciers in Mars’ mid-latitudes is extremely rare.

• The glaciers are currently frozen to their beds, but has this always been the case?
• Eskers (Fig 1) emerging from two mid-latitude glaciers [1-2] indicate at least two localized melting events beneath existing glaciers ~110-150 Myr ago (Fig 2).

Eskers indicate past glacial melting.

1 Ice at glacier bed melts.
2 Meltwater carves a tunnel through the ice.
3 Meltwater deposits sediment in the tunnel.
• Chris, University, 2015.
• Royal College of Physicians, 2015.

Are glacier-linked sinuous ridges in Chukhung Crater eskers?


The two sinuous ridge populations are morphologically distinct, supporting different origins.

• The esker-like ridges are younger, more sinuous, and have sharper crests than the inverted channel-like ridges (Fig 5).
• However, the ridges have similar dimensions, so differences in crest morphology could be due to differences in degradation state rather than formation mechanism.

Fig 5: (a) Esker-like ridge (Ssr) superposing inverted channel-like ridge (Usp) (extent in Fig 3. CTX image P04_002577_2186_XN_38N072W), and (b) topographic profiles AA’ and BB’ from (a) extracted from digital elevation model generated from HRSC images ESP_017477_2190 and ESP_018545_2190 [6].

The esker-like ridges ascend valley walls.

• Esker-forming meltwater can ascend bed slopes under hydraulic pressure in subglacial tunnels [8]. Ascent of valley walls (Fig 6b) is inconsistent with deposition under gravity-driven flow in subaerial fluvial channels.
• However, ascent of slopes could be inferred from differential erosion under the alternative inverted channel hypothesis, rather than a primary feature.

Fig 6: (a) Esker-like sinuous ridges (white arrows) emerging from moraine-like deposits (Gtr & Rpu) at glacier (Vff) termini. CTX image P04_002577_2186_XN_38N072W. (b) Esker-like ridge ascending a valley wall. HRSC image ESP_003303_2183.

There are challenges for the esker hypothesis.

• The esker-like ridges could be a second population of inverted channels.
• Glacial deposits (Vff, Gtr, Rpu) covering the southern crater floor hinder scrutiny of the relationship of the esker-like ridges to pre-glacial fluvial deposits.
• Eskers are ice-contact deposits but there is no additional evidence for past glaciation northward of the moraine-like deposits (Gtr & Rpu).
• There is one esker-like ridge system on the northern floor, where there is no evidence for glaciation.

Lessons from Chukhung Crater.

• Even where sinuous ridges emerge from existing glaciers, and where they have esker-like non-slope-conforming topographic signatures, conclusive identification as eskers is complicated by similarities in form between inverted channels and eskers [e.g. 8].
• Regional mapping and quantative 3D morphometric analyses [e.g. 2, 9] should always be performed before an esker origin can be concluded. Such analyses are ongoing for Chukhung Crater.


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