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.
4. A ridge of sediment (an esker) is left when the ice retreats.

Are glacier-linked sinuous ridges in Chukhung Crater eskers?


Chukhung Crater hosts two populations of sinuous ridges.

- Esker-like ridges (Srr, Fig 3) emerge from moraine-like deposits (Gtr & Rpu, Fig 3) bounding the termini of putative debris-covered glaciers (Vtf, Fig 3) on the southern crater floor.
- Inverted channel-like ridges (within Usp, Fig 3) extend from fluvial valleys on the northern crater wall. They formed prior to glaciation of the crater. Their formation does not require glacial meltwater (Fig 4).

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 mechanics.

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 inherited from differential erosion under the alternative inverted channel hypothesis, rather than a primary feature.

There are challenges for the esker hypothesis.

- The esker-like ridges could be a second population of inverted channels.
- Glacial deposits (Vtf, 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 quantitative 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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