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New evidence for geothermal controls upon recent basal melting of mid-latitude glaciers on Mars

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Diagnostic evidence for past melting of putative debris-covered glaciers (DCGs) in Mars' mid-latitudes [e.g. 1-2] is extremely rare. As such, it is widely believed that these DCGs have been perennially frozen to their beds in cold-based thermal regimes [e.g. 3] since their formation ~40 Ma to 1 Ga [4-8]. Here, we present a geomorphic map and propose a landsystem model that challenges this paradigm. We identify a sinuous ridge emerging from the terminus of a DCG in the broad rift zone NE of the Tharsis volcanic province. We interpret this ridge as an esker formed by deposition of sediment within a subglacial meltwater conduit. This is only the second esker-like ridge to be identified in association with a mid-latitude DCG. Recent work [9] identified a complex of esker-like ridges on the foreland of an extant DCG in Phlegra Montes, for which high-resolution analysis is ongoing [10]. Significantly, both candidate eskers are located within graben. Graben are topographic troughs formed by crustal extension and are commonly associated with elevated geothermal heat flux [e.g. 11]. A paucity of meltwater morphologies associated with DCGs elsewhere in Mars' mid-latitudes implies that atmospheric warming alone was insufficient for widespread basal melting. We argue that, during deglaciation, atmospheric warming supplemented enhanced geothermal heat flux within graben such that the basal temperature threshold for basal melting of DCGs was surpassed in these locations [9]. This has implications for the search for recent life on Mars, as it helps constrain the likely regions of recent meltwater production within protected subglacial environments. As eskers are exposed relicts of subglacial drainage systems, they are accessible to landed missions without the high-risk requirement to drill through remnant decametre-thick debris-mantled ice.

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