6. Conclusions

Observations of the morphology of Protonilus Mensae gully deposits are interpreted to indicate local dominance of water-containing debris flows in the incision of gully channels, the deposition of gully fans, and the formation of unusual lobate features. These observations are consistent with top-down melting of debris-covered ice and initiation of debris flows by the interaction of rapidly generated liquid water with the lithic component of the latitude-dependent mantling deposits and pasted-on terrain in which the gullies form. The observed suite of landforms is diagnostic of wet debris flow processes and suggests that we have identified an unusual environment in which the wet debris-flow formational end-member is the dominant gully forming process. Elsewhere on Mars gully morphology may be more consistent with a range of other sediment transport mechanisms including fluvial erosion, hyperconcentrated flow, and low-strength mudflows (that deposit as fans rather than lobes). The Protonilus Mensae lobes provide compelling evidence that 1) martian gully-forming processes involve liquid water; 2) the source of the water is likely to be the melting of near-surface ice associated with the latitude-dependent mantle; and 3) there are a range of water and sediment transport processes involved in gully formation.

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