SEMI-ARID AND PERIGLACIAL GULLIES: IMPLICATIONS FOR MARS

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We conducted survey and remote sensing analysis of semi-arid gullies at Island Lagoon, Australia and sub-humid gullies at Pasture Hill, New Zealand and compared them with two Martian gully sites in order to gain insight into the roles that local geology, climate and slope play in influencing gully evolution and morphology.

We found that Island Lagoon gullies were formed by catchment-derived overland water flow eroding material beneath cap rock layers. This has been topographically constrained to form V shaped channels that terminate in fluidised depositional aprons. The Pasture Hill gullies were formed via a complex interaction of frost processes, relatively large amounts of rainfall and snowmelt. This has led to a complex regime of erosion, deposition and subsequent activity on these gullies, with mass wasting processes occurring in the upper alcoves and debris flows being the dominant water-based process occurring on the lower gully slopes and depositional fans.

Comparison of morphology of the Martian gullies with the terrestrial sites suggested that although the gullies had predominantly been carved by surficial flow of liquid water, through pore pressure related processes, the observation of additional erosive features at the Martian site also suggested other processes such as dry flow or surface creep may be acting on this site in a similar manner to the Pasture Hill gullies. Thus, it is likely that the Martian gullies evolved through a number of fluvial and dry related processes.

All of the gullies we analysed revealed close association between gully and host slope, with multiple areas of erosion and deposition occurring throughout gullies, not just confined to specific depositional aprons. This indicated that gully slopes were more dependent on the host escarpment, the thickness of erodible material and climatic influences, while generally decreasing in value from alcove to depositional region. It also indicated a more complicated regime for gully formation involving a number of processes at varying levels of intensity.

Traditional indicators of water related activity such as slope and sinuosity need to be placed into context of the environment of the study site. In addition, other, non-liquid erosive agents such as frost creep and dry mass wasting are probably common features in shaping the on-going evolution of Martian gullies.

Fig 1

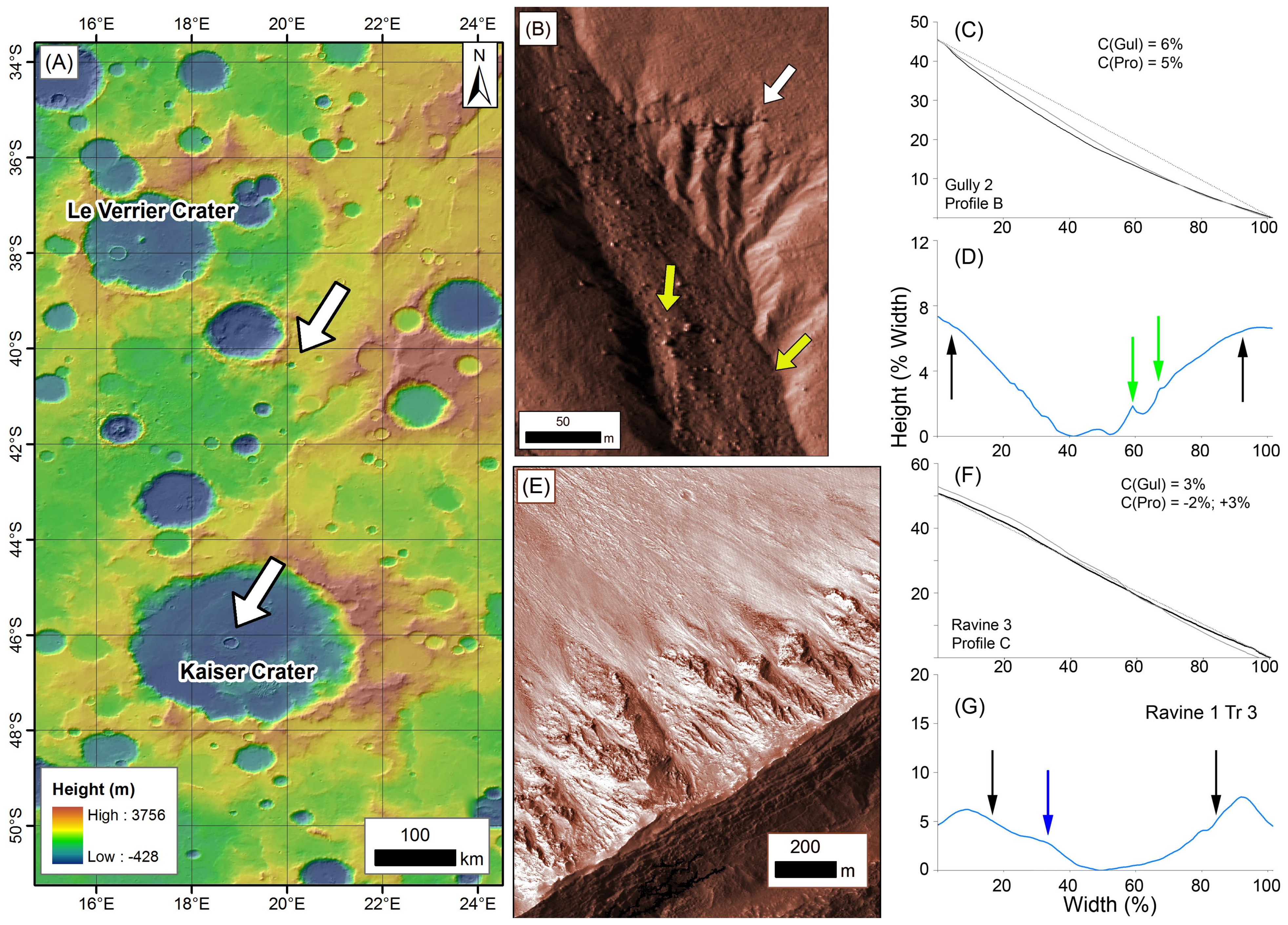
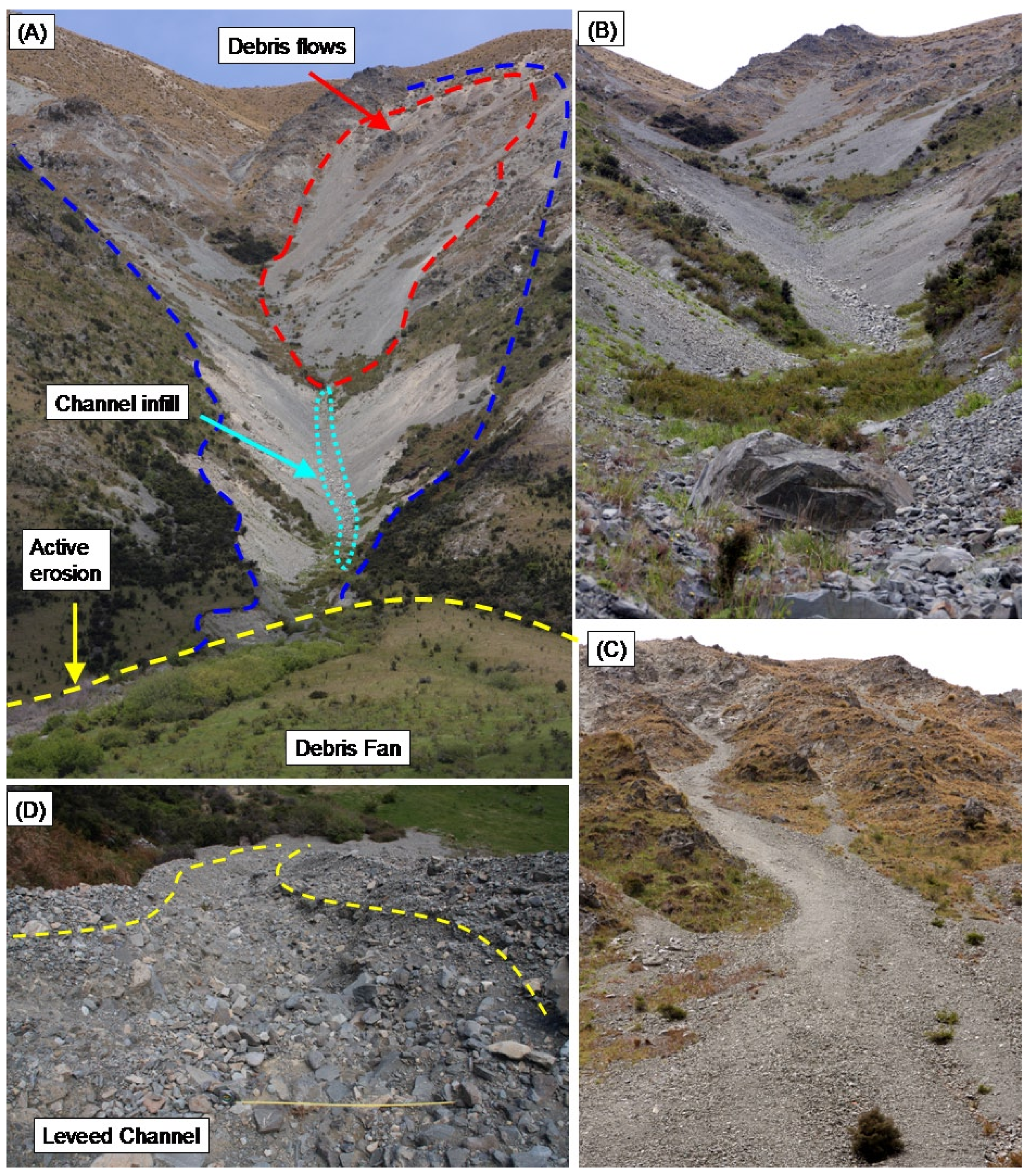


Fig. 1. Overview of studied Martian sites in Noachis Terra (From Hobbs et al. 2012). (A) Elevation overview of studied gully sites including crater studied in Hobbs et al. (2012) and within Kaiser Crater. (B) Gullies on the northern rim of the Noachis Terra crater. (C) Long profile of gully showing concave appearance and close association with host slope. (D) Cross profile of the northern crater rim gullies with additional channel Marked by green arrows. (E) Dry ravines located on the crater's southern rim. (F) Dry ravine long profile revealing much flatter curve than (C). (G) Dry ravine cross profile showing influence of bedrock intrusion marked by blue arrow.

Fig 2



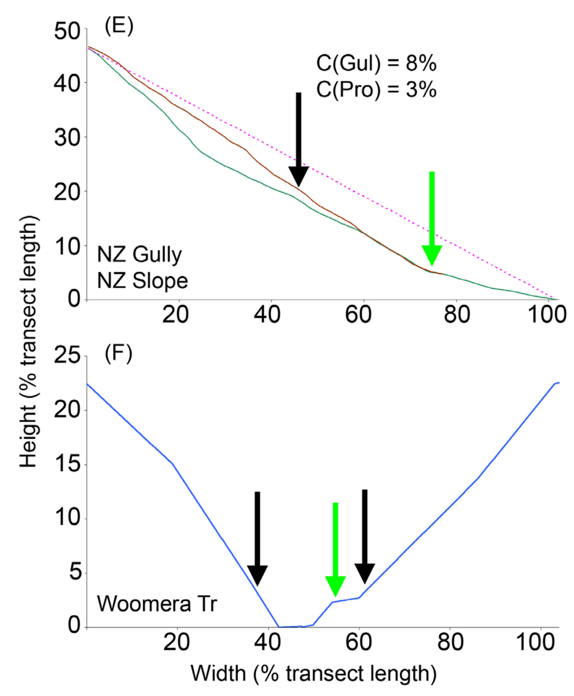


Fig. 2. Pasture Hill gullies, New Zealand. (A) Overview of gully 4, typical of in-filled gullies at Pasture Hill with prominent features marked. (B) Detailed view of boulders and material deposited into alcove and channel floor. (C) Detail of constrained talus flow in gully alcove. (D) Leveed channel in gully depositional apron. (E) Pasture Hill gully and host slope profile. (F) Island Lagoon gully cross profile