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Comparing the topographic long profiles of gullies on Earth and Mars

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Liquid water is not stable under the present atmospheric conditions on the martian surface. Hence, the discovery of widespread recently active kilometre-scale gullies that resemble those carved by water on Earth [1,2], was extremely surprising. Some authors suggest that either carbon dioxide driven processes or dry mass wasting could explain these features [3–6]. However, recent work has shown that some aspects of gully-morphology, such as braiding and streamlined features, are hard to explain with these mechanisms [e.g., 7,8]. In this study we have used topographic long profiles to investigate the formation mechanism of martian gullies.

On Earth it is recognised that certain forms of long-profiles can be linked to a particular process, for example, at equilibrium fluvial systems have a profile curve of exponential decay [9]. However, these shapes have not been generalised for kilometre-scale landforms, such as gullies. We used differential GPS data and airborne laser altimeter data on Earth (LiDAR) from NSA-funded NCALM and UK's NERC ARSF to generate profile-data for gullies with a fluvial and debris flow origin. On Mars we used stereo-images from the HiRISE camera (25 cm/pix) and generated the gully-profiles using the manual point-matching method of Kreslavsky [10].

We found that the shape of gully long profiles on Mars is similar to that of both fluvial and debris flow gullies on Earth. However, more of the martian gullies we have studied are similar to fluvial gullies than to debris flow gullies. The slopes of the gully long profiles on Mars tend to be shallower than fluvial gullies on Earth, but this can be accounted for by the difference in gravity between Earth and Mars.

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