



## **Present-day formation and seasonal evolution of linear dune gullies on Mars**

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Linear dune gullies are an enigmatic sub-type of martian gullies. As their name suggests they only occur on sandy substrates and comprise very long (compared to their width) straight or sinuous channels, with relatively small source areas and almost inexistent deposits. This specific morphology has never been observed on terrestrial dunes and its formation process on Mars is still unclear [e.g. 1, 2, 3]. Here, we present the results of the first systematic survey for these features in Mars' southern hemisphere and an in-depth study of six dune fields where repeat-imaging allows us to monitor the changes over time of these linear gullies. This study was performed with HiRISE images at 25-30 cm/pix and 1 m/pix elevation data derived from HiRISE stereo images. We find the latitudinal distribution and orientation of linear gullies is broadly consistent with the general population of martian gullies. They occur predominantly between 36.3°S and 54.3°S, and occasionally between 64.6°S and 70.4°S. They are oriented towards SSW (between 150°N and 260°N). In contrast with the general gully population, however, we find that these gullies are extremely active over the 5 Mars years of images. Activity comprises: (i) appearance of new channels, (ii) elongation of existing channels, (iii) complete or partial reactivation, and (iv) disappearance of gullies. Gully channels can elongate by an average  $\sim 100$  m per year. Their intense activity and the progressive disappearance of linear gullies argues against the hypothesis that these are remnant morphologies left over from previous periods of high obliquity millions of years ago. The activity of linear dune gullies reoccurs every year between the end of winter and the beginning of spring (Ls 167.4° - 216.6°), coinciding with the final stages of the sublimation of annual CO<sub>2</sub> frosts. This activity often coincides spatially and temporally with the appearance of Recurrent Diffusing Flows (RDF) – dark patches which surround the active site. South and SSW-facing dune slopes are those which preferentially host CO<sub>2</sub> frost deposits, however, only those dune slopes with angles  $\sim 13^\circ$  possess linear dune gullies, suggesting a slope-limited formation process. These observations provide a wealth of temporal and morphometric constraints that can be used to perform numerical modelling, to direct future image monitoring and guiding laboratory experiments which can be used to better constrain the formation process of these enigmatic features.

[1] Mangold et al., 2003. *J. Geophys. Res.*, 108 (E4), 5027. [2] Reiss et al., 2010. *Geophys. Res. Lett.* 37, L06203.

[3] Diniega et al., 2013. *Icarus* 225, 526-537.