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## The Morphologic Difference between Crater Slopes with and without Gullies on Mars.

S.J. Conway (1), N. Mangold (1), M.R. Balme (2), and V. Ansan (1)

(1) LPGN, CNRS/Univ. Nantes, 44322 Nantes, France, (2) PSSRI, Open University, Milton Keynes, MK7 6AA, UK  
(susan.conway@univ-nantes.fr)

Gullies on Mars are km-scale landforms that resemble small fluvial features on Earth. Their discovery [1] challenged the paradigm that over the last  $\sim 2$  Ga, Mars has been a dry, frozen desert. The gullies are found commonly in the mid-latitudes, have a pole-facing preference [e.g., 2] and are found many kinds of steep slope (valley wall, dunes, etc.). We have chosen to concentrate on gullies found on impact crater interior wall slopes, as this is the most common type [2]. The aim of our study is to determine whether the morphology of crater walls with and without gullies is different.

We chose three study areas, two in the southern hemisphere (where gullies are most common), Terra Cimmeria and Noachis Terra and one in the northern hemisphere, Acidalia Planum. All study areas extend over at least  $30^\circ$  of latitude, from  $\sim 25^\circ$  to  $55^\circ$  North or South. We mapped all craters using the catalog of [3] as a basis. We used HRSC elevation data at better than 100 m/pix to extract the slope and curvature of crater walls in the four cardinal directions. We mapped all the gullies on crater walls in the three areas with the aid of HiRISE, MOC, CTX and HRSC images, using polygons to delimit a slope section that contained gullies.

Consistent with previous investigations we found gullies concentrated around  $40^\circ$  latitude, with a pole-facing preference. We also found that east-facing gullies were common in both hemispheres. Gullies were most common in Terra Cimmeria and uncommon in Noachis Terra. We found that for a given latitude band and orientation gullies tend to be found on craters with the steepest slopes and the highest curvature. The lack of gullies in Noachis Terra can be explained by the lack of steep, concave slopes in the mid-latitudes of this region. In Terra Cimmeria we found that almost all steep, concave crater slopes hosted gullies, whereas in Acidalia, in the north, only 10-20% of steep concave slopes had gullies. Crater slopes with gullies in the north are steeper and more concave than those with gullies in the south. From previous studies we know that northern hemisphere gullies are more muted in appearance [4]. These differences between hemispheres point to a difference in formation conditions that we suggest is related to the climatic difference between the two hemispheres. We propose that the relative lack of seasonal  $\text{CO}_2$  frost in the north, particularly at high obliquity, means underlying water ice is less effectively preserved, so less melt is available for gully formation.

References: [1] Malin M. C. and Edgett K. S. (2000) *Science*, 288, 2330-2335. [2] Balme M. R. et al. (2006) *JGR*, 111, doi:10.1029/2005JE002607. [3] Salamuniccar G. et al. (2011) *PSS*, 59, 111-131. [4] Bridges N. T. and Lackner C. N. (2006) *JGR*, 111, doi:10.1029/2006JE002702.