

Critical Comment on

Malin M. C., K. S. Edgett, L. V. Posiolova, S. M. McColley, & E. Z. N. Dobreaseen (2006) Present-day impact cratering rate and contemporary gully activity on Mars, *Science* **314**, 1573-157.

Malin et al. (1) claim that liquid water is necessary for the formation of Martian gullies, so that newly-formed gullies require liquid water be present today just beneath Mars' surface. They reject the idea that gullies might form as dry granular flows of dust or sand (2,3) through an unfavorable comparison with Martian slope streaks (which are such flows (4)). The comparison is inapt; dry granular media can avalanche or as thin surficial layers (like slope streaks) or as deep catastrophic flows (5), which are most familiar on Earth as avalanches of dry powder snow (6). These climax snow avalanches can produce all the accepted characteristics of gullies (7,2): upslope terminations in theatre-shaped alcoves, distinctly carved channels with raised levees, and downslope deposits with lobate or fingered margins. Of course, Martian gullies do not form by flowing snow, but the physics of avalanches in granular media applies alike to dry snow on Earth and to dust and sand on Mars.

References and Notes

1. M. C. Malin *et al.*, *Science* **314**, 1573 (2006).
2. A. H. Treiman, *J. Geophys. Res.* **108(E4)**, DOI 10.1029/2002JE001900 (2002).
3. T. Shinbrot *et al.*, *Proc. Natl. Acad. Sci.* **101(23)**, 8542 (2004).
4. R. Sullivan *et al.*, *J. Geophys. Res.* **106**, 23,607 (2001).
5. A. Daerr, S. Douady, *Nature* **399**, 241 (1999). Shallow 'triangular' avalanches form at lower slope angles and small thicknesses of mobile grains; deep 'upward-propagating' avalanches form at greater slopes and greater thicknesses of mobile grains.
6. e.g., D. McClung, P. Schaerer, *The Avalanche Handbook*, Mountaineers

Press, Seattle WA (1993).

7. M. C. Malin, K. S. Edgett, *Science* **288**, 2330 (2000).

9. I thank the MOC staff who have worked tirelessly to make its images readily accessible to the scientific community. I am grateful for collaborations, over several years, with M. Louge, T. Shinbrot, and R. Morgan. Lunar and Planetary Institute Contribution #1xxx.