COMPARISON OF MARTIAN GULLIES AND LUNAR CRATER-WALL LANDSLIDES. Gwendolyn D. Bart, *Univ. of Arizona, Dept. of Planetary Science, 1629 E. University Blvd, Tucson, AZ 85721 (gwenbart@lpl.arizona.edu).*

Summary: I present lunar landslides that bear a striking resemblance to some martian gullies, despite the lack of water on the Moon both today and in the past. This observation indicates that gully features can be formed via a dry landslide mechanism. Thus on Mars, morphology alone is insufficient to determine the mechanism of formation of these features.

Introduction: In 2000, Malin and Edgett (1) reported the observation of martian gullies on steep terrain. Gullies have three distinctive characteristics: an *alcove*, a *channel*, and a deposition *apron*. The *alcove* is the highest on the slope and the source for the channel. If more than one gully is on the slope, their alcoves frequently emanate from the same layer in the cliff. The channel heads appear to be clear of debris, suggesting efficient material transport. The *channels* are incised into the cliff; they are topographic, not merely albedo features. In some cases they form meanders and branching patterns. The deposition *aprons* at the bottom of the cliff resemble terrestrial alluvial fans. (Gullies are morphologically distinct from slope streaks, which are observed both on Mars (2) and the Moon (3). Slope streaks are formed by dry landslides and are detected as albedo features, not topographic channels. They move straight down the slope ignoring impediments and gradually fan out downslope.)

Malin and Edgett (1) proposed that the martian gullies formed by groundwater seepage in the recent past. They based their hypothesis primarily on gully morphology, comparing martian gullies with terrestrial gullies whose formation involves the action of liquid water. Although liquid water is not stable at current martian temperatures and pressures (4), Mellon and Phillips (5) found that normal geothermal heating could raise the temperature of subsurface water to liquid temperatures if the overlying regolith was sufficiently insulating. However, liquid water may not be necessary to form the gullies. Treiman (6) proposed gully formation by avalanches of fine granular material without the presence of liquid water. Furthermore, it has been shown experimentally (7) that the flow of dry granules can exhibit features similar to those seen on Mars.

In contrast to Mars, no lunar features formed by the action of liquid water. The Moon has no evidence for liquid water floods or valley networks. Furthermore, the samples returned from the Moon are drier than earth rocks. Hence, if the dry landslide hypothesis for the formation of martian gullies is correct, we might expect to see similar features on the Moon, where there is no liquid water. We do. In this abstract I report the observation of lunar crater rim landslides which are morphologically similar to the martian gullies, suggesting that the martian gullies need not have been formed by liquid water.

Comparison of Martian and Lunar Features: One lunar example is crater Dawes (Fig. 1), located at 27.4°E, 12.2°N. Dawes was photographed by *Lunar Orbiter V*, image 070-H2. The crater is near the edge of Mare Tranquilitatis, near Mare Serenitatis. It is flat floored, with a diameter of 17 km and a rim-to-floor depth of 1.5 km. Schultz (8) refers to the walls of this crater as "screelike."

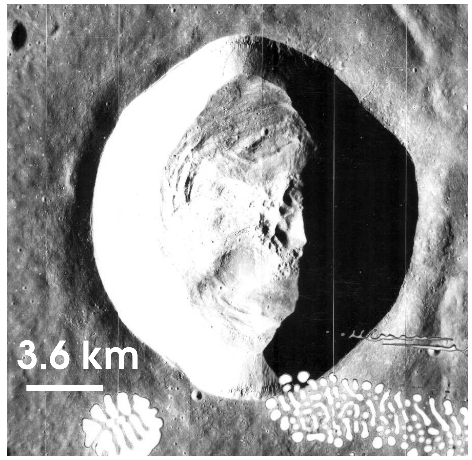

Figure 1: Crater Dawes. 27.4°E, 12.2°N.

The upper slopes of the northern wall exhibit well defined "lengthened" alcoves forming a "badlands" morphology (Fig. 2), as described by Malin and Edgett (1). The alcoves are all located the same distance below the crater rim; Malin and Edgett (1) suggested that alcoves originating from the same layer in the crater wall was characteristic of liquid water gullies. The channels (Fig. 2) are not mere albedo features, they are clearly incised into the wall. Their paths are not perfectly straight like slope streaks would be, but join and branch in places. The final important characteristic of a gully is the deposition apron, which is also visible in the lunar image (Fig. 3), yet can not have been formed by liquid water. Hence, these lunar landslides exhibit all the features of martian gullies, yet were not formed by liquid water. Thus, it *is* possible to form gully features without liquid water.

Dry Formation: Treiman (6) is a vocal proponent for the formation of martian gullies from dry granular flows. He suggests that the gullies are a case of landslides larger than slope streaks (2) but smaller than large-scale landslides such as those in Valles Marinaris (9).

Shinbrot et. al. (7) experimented with flows of dry granular material. They successfully reproduced the alcoves, channels, and aprons of typical martian gullies.

Treiman (6) suggests that dry flows are uncommon on Earth because water *is* abundant, wetting fine grain material and changing its rheological properties. On Mars, wind deposited fines may persist for some time until a slide is initiated, perhaps by wind, wind blown material, or by additional deposition of fines in an unstable configuration. On the Moon, fines would not be deposited by the wind (there is no atmosphere) but rather by impact ejecta from micrometeorites, small nearby craters, or large distant craters – the mechanism which forms

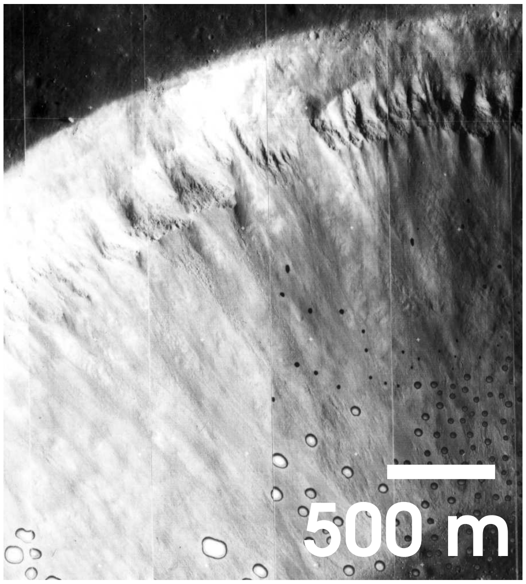

Figure 2: Alcoves and channels in crater Dawes.

the lunar regolith. Heldmann and Mellon (10) argue against the dry flow hypothesis on the basis of martian global wind patterns; however, wind appears to be irrelevant to gully formation since the Moon has no wind.

Conclusion: Does the discovery of lunar “gullies” mean that the martian gullies were not formed by liquid water? Not necessarily. After all, the martian gullies also resemble terrestrial gullies formed by liquid water. But it does mean that on Mars, morphology alone is insufficient to determine the mechanism of formation of these features.

Formation of martian gullies by liquid water would have important implications. Near surface water would be a valuable resource for future human explorers of Mars, and would reduce mission costs by decreasing the mass of water that must be shipped. Also, liquid water near the surface of Mars would greatly increase the likelihood of native life. However, we cannot yet say with confidence whether near surface water is, or was recently, present.

References: [1] Malin M.C. and Edgett K.S. (2000) *Science*, *288* 2330–2335. [2] Sullivan R., Thomas P., Veverka J., Malin M., et al. (2001) *J Geophys Res*, *106* 23,607–23,634. [3] Howard K.A. (1973) *Science*, *180* 1052–1055. [4] Ingersoll A.P. (1971) in IAU Symp. 40: Planetary Atmospheres, 247. [5] Mellon M.T. and Phillips R.J. (2001) *J Geophys Res*, *106* 23,165–23,180. [6] Treiman A.H. (2003) *J Geophys Res*, *108*(E4) 12. [7] Shinbrot T., Duong N.H., Kwan L., and Alvarez M.M. (2004) *Proceedings of the National Academy of Science*, *101*(23) 8542–8546. [8] Schultz P.H. (1976) Moon morphology: Interpretations based on Lunar Orbiter photography, Austin, University of Texas Press. [9] Lucchitta B.K. (1979) *J Geophys Res*, *84*(B14) 8097–8113. [10] Heldmann J.L. and Mellon M.T. (2004) *Icarus*, *168* 285–304.

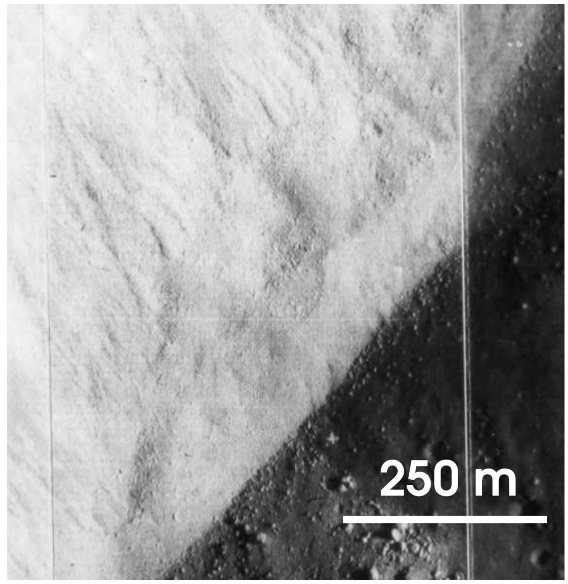

Figure 3: Deposition apron in crater Dawes.

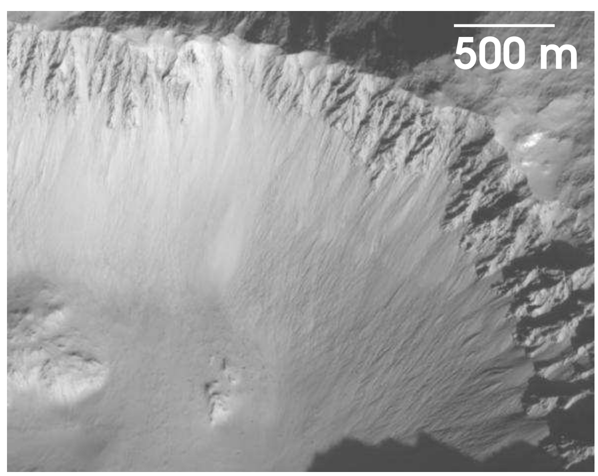

Figure 4: Similar gullies on a martian crater (MOC image number m2300394). 42.18°S, 157.20°E.