GULLY ANALYSIS BY THE 2009 MARS SCIENCE LABORATORY.

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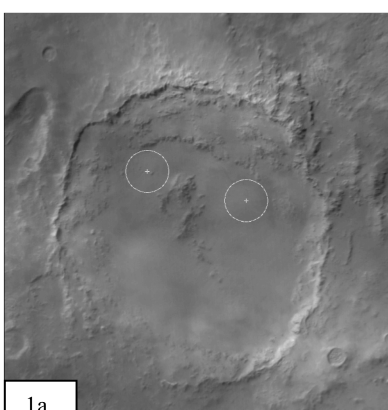
The discovery of the young gullies on Mars revealed the Martian surface to be much more geomorphically active in relatively recent times than previously thought [1]. A critical debate has developed over the origin of these gullies [e.g.2-4]. Generally it is thought these gullies are cut by mass flows, but proposals range widely as to the cause of the flows and the source and amount of water involved. These proposals have suggested that the flows were caused by: seepage from groundwater exfiltration, melt-water from ice-rich mantle deposits, gaseous CO_2 release, or dry granular flows. These (and other) interpretations suggest very different histories for Martian water, with profound implications for Martian climate, hydrologic cycle, contemporary water availability and the possibility of environments suitable for life. Due to the unfortunate tendency for different physical processes to produce similar landforms, topographic data alone may not provide a definitive conclusion as to the origin of the gullies. Ground observations by the Mars Science Laboratory (MSL) can, however, can provide answers, and in so doing reveal much about the recent climate and erosional history of Mars.

There are several significant challenges to directing the MSL to investigate gullies, including: 1) access, 2) appropirate landing opportunities, and 3) planetary protection constraints. Gullies commonly originate on slopes too steep to be accessed by the MSL. Many gullies do extend to lower gradient basal slope, however, where they may terminate in topographic lobes or transition to fan shaped depositional surfaces. Some of these gullies could be accessed from the downslope depositional region.

Gullies appear to be less common on the crater walls of larger craters, making the number of sites with adequate landing opportunities very limited. We assume that the landing site would have to be in a crater, because the MSL could drive up to the gully, but may not be able to drive down to the gully if it landed on the adjacent plain. Figure 1a and b show two craters with strongly developed gullies that are large enough that a 20 km diameter landing ellipse easily fits on the crater floor. In the Wirtz Crater in particular (Figure 1b), there are well developed gullies with at least one impact crater on a gully apron deposit suggesting sufficient antiquity to satisfy possible constraints on investigations due to planetary protection requirements (i.e. there might be no threat that the gully with the impact crater can become active in modern times).

MSL analysis of the walls of even a single gully could confirm current theories or radically change our view of Martian hydrology. Stratigraphy found in the walls would distinguish transport mechanisms (and the role of water) and epidicity of deposition. For example, collapse structures would indicate post depostion melting of an ice-matrix, and well sorted sediments with cross-bedding would imply flowing free water. If present to begin with, the gully sediments might have preserved organic compounds.

References: [1] Malin, M. C. and K. S. Edgett (2000) *Science, 290*, 1927–1937. [2] Marquez, A. et al., *Icarus*,179, 398-414. [3] Heldmann, J. L.,et al., *J. Geophy. Res.*, 110,doi:10.1029/2004JE002261. [4] Berman, D. C., et al., *Icarus*, 178, 465-486.



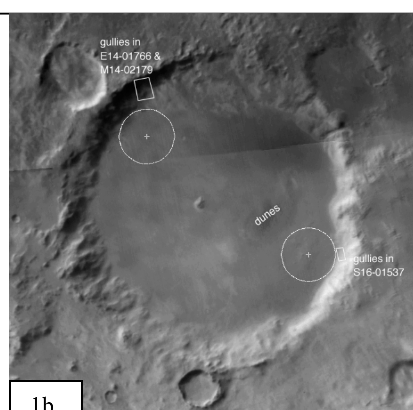


Figure 1. Potential landings sites in (1a) **Hale Crater** (35.7°S, 36.6°W) and (1b) **Wirtz Crater** (48.6°S, 26.0°W). Diameter of circles ~ 20 km. Landing ellipses are ~ –2.4 km elevation for Hale Crater and about -0.6 km for Wirtz Crater, hence EDL conditions are met. There appears to be trafficable routes to nearby (to landing ellipses) routes.