CORRELATION OF REGIONAL TOPOGRAPHY AND MARTIAN GULLY ORIENTATION. T. L. Allen[1], M. B. Wilhelm[2], J. L. Heldmann[3], and S. J. Allen[4], [1]NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035. Trinity.L.Allen@gmail.com, [2]NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035. mbwilhelm47@yahoo.com, [3]NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035. Jennifer.L.Heldmann@nasa.gov, [4]NASA Ames Research Center.

Introduction: Liquid water emanating from a subsurface aquifer has been proposed as a possible explanation for the formation of gully features on Mars [1, 2]. In this scenario, a correlation may be expected between the location of gullies and the location of regionally downward sloping terrain due to the resultant hydraulic gradient, which would slope downward causing water in an aquifer to move towards the gully site. A comprehensive survey of gully orientation angles and the corresponding regional topographic trends is presented here to further test the shallow aquifer model.

Methodology: We searched all Mars Orbiter Camera (MOC) narrow angle images in latitudes known to contain gullies, approximately 30°-75° in both the northern and southern hemispheres, from mission phases AB1 through S10. Gullies were identified primarily by the presence of a distinct, v-shaped channel emanating from the base of a theater shaped alcove. Gullies located on Hale crater, central peaks, and dunes were omitted due to significant morphological differences from classical gullies found on most crater, trough, and pit walls [3].

Only gullies found on crater walls were used for this study though classical gullies were also found on trough and pit walls. Craters with significant coverage were used for orientation angle measurements while only craters with full coverage were used for regional topography analysis. Significant coverage is defined as imagery data spanning at least 100° of orientation along a crater wall or a cross-sectional image showing a portion of both the north and south facing walls.

In order to analyze the possible bias for poleward facing slopes during the imaging process, the angular extent of MOC narrow angle image coverage for each of the craters was recorded.

To determine the locations of gullies and gully systems we measured the orientation angles of up to twelve individual gully channels in each map projected MOC narrow angle image. Repeated measurements of the same gully were avoided where possible by discarding repeated MOC images and visual inspection of overlapping images.

Elevation contour plots of the region imaged by the MOC wide angle image corresponding to the narrow angle image of interest were created using MOLA gridded data at 128 pixels per degree for each of the fully covered, southern hemisphere craters. These plots were used to determine where the regional topology slopes towards the crater of interest. Small scale, local features were ignored initially in favor of large scale regional trends.

Results/Analysis: A total of 1790 images containing gullies were found. The exclusion of gullies in Hale crater, central peaks, and dunes and the requirement of significant coverage narrowed the initial set of 1790 images down to 1207 images. Of these 1207, 170 images are in the northern hemisphere and 1037 are in the southern hemisphere. There are 535 individual craters containing gullies, which account for 757 individual images. The remaining images represent gullies in troughs, pits, and chaotic terrain. Of the 535 craters containing gullies, 424 are in the southern hemisphere, and 49 of these can be seen in their entirety using only the MOC narrow angle images in our data set.

Slope Coverage: There is no significant poleward coverage bias in either the northern or southern hemispheres. There are, however, more north/south images than east/west images in the northern hemisphere. These results can be seen in figs. 1a and 2a.

Gully Orientations: Gullies are found at all orientations on the walls of craters, troughs, and pits. However, there appear to be more gullies oriented towards the pole in the southern hemisphere, as indicated in fig. 1b. The corresponding northern hemisphere data is shown in fig. 2b and reveals that there is no apparent poleward preference in the northern hemisphere. There is a conspicuous decrease in the number of east/west facing gullies in the north, but this could be the result of imaging bias as there are fewer east/west facing images. These results are in agreement with previous works concerning possible poleward biases though there is no previous mention of fewer east/west facing gullies in the northern hemisphere [4, 5, 6].

Regional Topography: For the 49 craters analyzed, approximately 70% show a significant correlation between the location of gullies and the location of regionally downward sloping topography. Of these, approximately 50% are perfectly correlated with all of the gullies lying in locations where the regional topography is sloping towards the crater. The angular extent and orientation of the regional down sloping topography relative to each crater is shown along with the gully orientation data in fig. 3.

Preliminary data suggest that down slope topography due to localized features could lead to full correlation between gully locations and down slope topography for the 30% of images that currently do not show correlation with regional down slope topography. This could indicate that local topological features, when present, play a larger role in gully formation than regional trends.

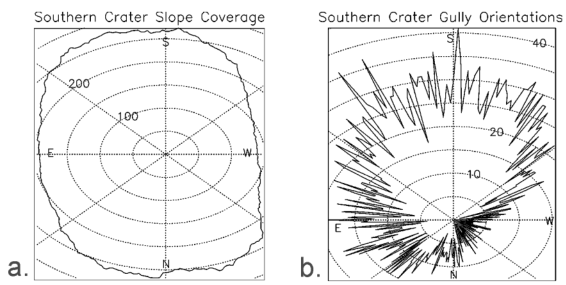

Figure 1: a) Number of gullies at each orientation angle in the southern hemisphere. b) Number of images showing each orientation angle. Note that 90° indicates a poleward facing gully or slope and all values have been rounded to the nearest degree.

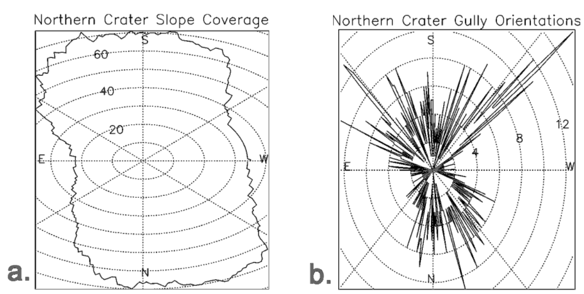

Figure 2: a) Number of gullies at each orientation angle in the northern hemisphere. b) Number of images showing each orientation angle. Note that 270° indicates a poleward facing gully or slope and that all values have been rounded to the nearest degree.

Conclusions: There does appear to be a poleward preference in orientation for southern hemisphere gullies that is not caused by imaging bias. A poleward preference is not seen in the northern hemisphere, however, and gullies can be found on all slope orientations in both hemispheres. This suggests that insolation may not be the driving factor behind gully orientation. Gully orientation may instead be linked to regional topography, as suggested by the 70% correlation between regional down slope topography and gully location.

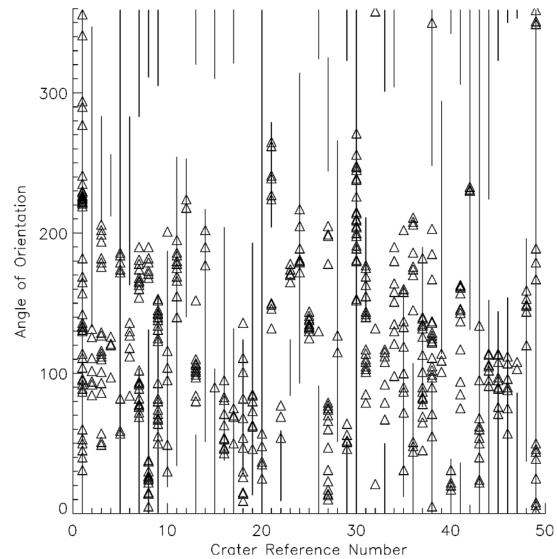

Figure 3: The angles for which surrounding topography slopes towards the crater (lines) as well as the orientation angle measurements for the individual gullies in that crater (triangles).

The possible link between gully location and regional topography could help explain the mechanism for water flow in a subsurface aquifer since the hydraulic gradient is affected by topography on a regional scale. Thus a correlation between down slope gradient and the location of gullies suggests that water, if present in a subsurface aquifer, may flow towards the locations where gullies are found. If this water reaches the crater wall it could breach the surface to form gullies.

Further work: Along with further investigation of the effects of small localized features, the research will also be extended to include regional topography and hydraulic gradient analysis for all imaged features, including both northern and southern hemisphere craters, troughs, and pits. Modeling of subsurface water flow and seepage forces will also be used to test the theory that water may be originating underground and flowing towards the locations where gullies are observed on the martian surface.

References: [1] Malin M. C. and Edgett K. S. (2000) *Science, 288,* 2330-2335. [2] Mellon M. T. and Phillips R. J. (2001) *J. Geophys. Res. 106,* 23165-23179. [3] Heldmann J. L. et al. (2005) *J. Geophys. Res., 110,* E05004. [4] Heldmann J. L. and Mellon M. T. (2004) *Icarus, 168,* 285-304. [5] Heldmann J. L. et al. (2007) *Icarus, 188,* 324-344. [6] Balme M. et al. (2006) *J. Geophys. Res. 111,* E05001.