COMPARATIVE STUDY OF GULLIES IN KAISER CRATER ON MARS. N. H. Glines[1] and V. C. Gulick[2], [1]NASA Intern program/NASA Ames (gline22n@mtholyoke.edu), [2]NASA Ames/SETI Institute. Both at NASA Ames Research Center, MS 239-20, Moffet Field, CA 94035.

Introduction: The ~200 km wide Kaiser Crater is located in the Noachis quadrangle of the southern highlands of Mars (~46°S, 340°W). Kaiser Crater is known for its dune field and active dune gulles, but also has fascinating gullied craters on its interior and local exterior. Gullies are common to these mid-latitudes, mostly appearing between ~30^{o} to 45^{o} [1]. The larger crater at the center of Kaiser (Figure 1a) and the crater in Figure 1b are of interest because they are heavily gullied, share patterns of gully appearance, and share conditions of a similar microclimate, being neighbors within the larger crater.

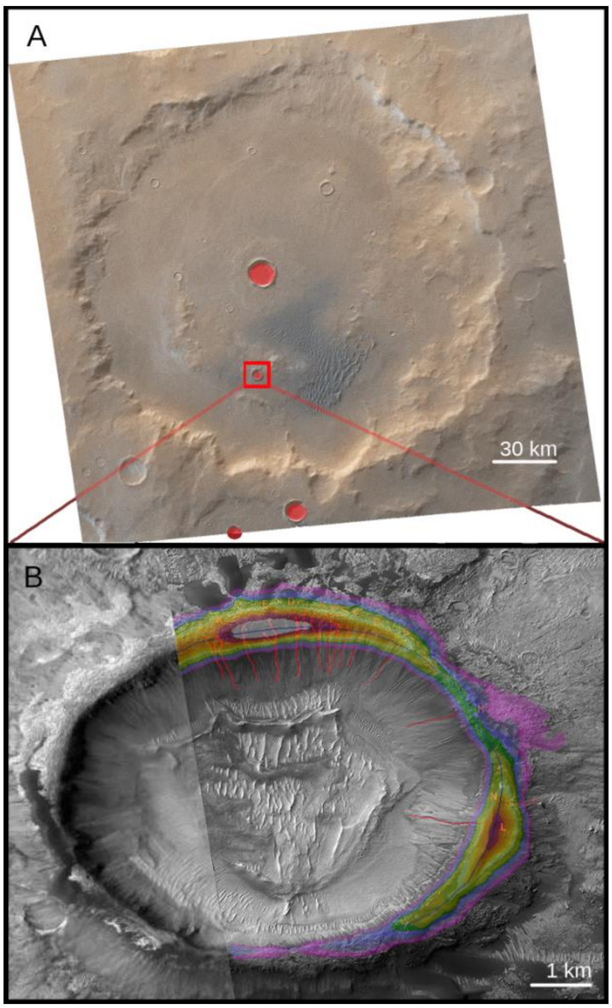

Figure 1: (a) Kaiser crater, and gullied craters in red in this MGS MOC2-272 image [2] (b) Detail of the crater of interest, HiRISE PSP_006820_1325 [3] with crater rim elevation, over CTXB06_011949_1331_XI_46S341W [4] .

HiRISE has produced a Digital Terrain Model (DTM) of the eastern half of the smaller crater seen in Figure 1b, allowing for the pursuit of more in-depth study of this region, such as study of sediment transport volumes and measurements of gully spatial profiles.

The majority of well-developed gullies (incised bedrock, wide alcoves, terraces, large depositional aprons) in both craters appear mostly on poleward-facing slopes. Although there is a lack of consensus toward a global orientation preference, some previous global surveys have demonstrated that gullies below ~45^{o} are mostly oriented towards the poles [5]. Although these two craters are slightly above 45 ^{o}, they generally support this poleward orientation. Using the HiRISE DTM of this smaller crater we see that in addition to poleward-facing slopes being the most populated by gullies, the longest and most well-defined gullies also seem to preferentially form under points of high elevation (Figure 1b).

This smaller crater has some unique characteristics, such as levies and terraces, and bedrock incision. The pole-ward facing high elevation gullies have the most well-developed alcoves and bedrock incision, while the eastern slope high elevation gullies do not appear to have a defined alcove and instead are 'wide-necked' and exhibit possible terrace features (Figure 4).

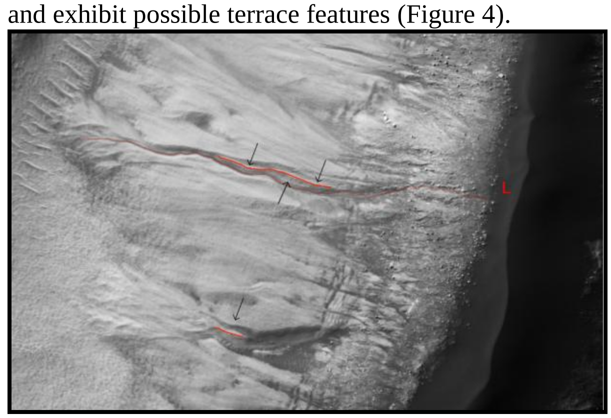

Figure 4: Suspected terracing in gullies on the southeastern crater wall. The Gully L center stream line is traced from the base of the dune to the tail of the apron.

The sinuosity of Gully L may be also indicative of a liquid water phase, as the 30-80m wavelengths are greater than necessary for a simple response to topography [6].

No gullies appear from the southern crater rim, which could be from the lack of wall height for a gully to form on, or because it is equatorial-facing. The larger interior gullied crater also lacks southern rim gullies.

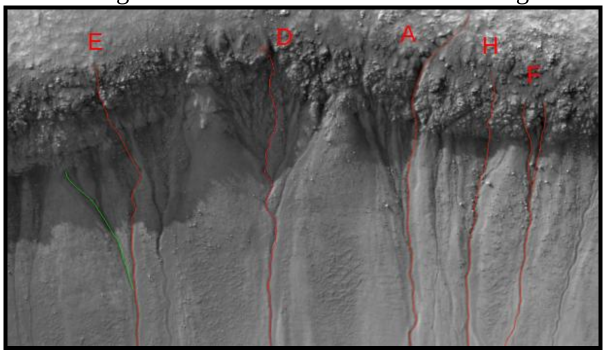

Figure2 : North crater wall of gullies with red center stream lines: bedrock incision and branching alcoves.

Where gully incision appears greatest, more stream lines converge in the alcove. It is a challenge to accurately represent one gully by a single path; attempts were made by determining the deepest-cut or most recent path of downslope activity, although sometimes (Gully F, Figure 2) both channels merge evenly, implying simultaneous stream flow.

Being amidst a dune field, this crater may have seen periodic sand infill in the past. Although dune sand might obscure parts of gullies on the eastern wall, most center stream line (CSL) paths have remained visible. These eastern gullies are at lower elevations where it might be easier for material to enter the crater. These gullies have one or two merging stream lines, whereas north wall gullies have alcoves with five or more merging streams. Closely-spaced anastomosing streams could have resulted in a general slope failure, which may indicate the original wall was higher the past.

Stream lines appear to start at different heights along the crater wall. The short green stream line merging into Gully E (Figure 2) contrasts with the deeply eroding Gullies E, D, and A.

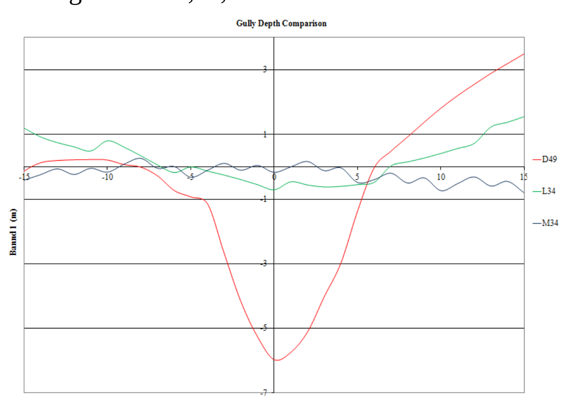

Figure 3: Maximum CSL depth of gullies on the north (red), northeastern (blue), and southeastern (green) crater walls, with gully stream lines centered on the y-axis.

Figure 3 shows a simplified view of a general observed trend. When all gullies are considered, they fall into these three categories that show a contrast between gully incision on different facing walls of the crater.

Gullies on the north wall (A, D, E) have the deepest incision into the alcoves (represented by Gully D in Figure 3) which cuts ~6m into the rock at its deepest point. Gullies on the northeastern slopes (B,G,M) have lower peak elevation, and even at their deepest, these gullies (represented by Gully M in Figure 3) have CSLs that are barely distinguishable from surrounding terrain in a spatial profile. The third category belongs to the southeastern terraced gullies (Gully L in Figure 3), where the alcove is 'wide-necked', and the CSL hardly cuts into the ground at all.

Future study will be made into comparing this crater's gullies to others in the Kaiser Crater region. There is a ~5km craters beyond the southern rim of Kaiser crater (Figure 1) with similar gully features to the crater discussed here, and another ~5km crater in the northern half of Kaiser Crater that has no gullies on its walls. In a similar crater microclimate, at a similar elevation and latitude, one might expect both craters to share gully features. Further investigation into the differences between these two neighboring craters could aid our understanding of conditions necessary for gully formation in this region.

The proximity to local dune field gullies could provide a good contrast study as well. There is a notable ~2.5km long sand dune riding the southeastern rim of this smaller crater (Figure 1b). In the past, dark dune material has slid into the gullies below, and as more material shifts, it would be interesting to observe the material traveling down a gully without the aid of liquid water flow.

Comparing and contrasting local gullies could be a helpful way to distinguish between a gully formed by briefly occurring liquid flowing water at the surface, or by other methods such as the sublimation of CO_2 or dry wall slumping events.

References:[1] Malin, M.C., Edgett, K.S., (2000a). Science 288, 2330–2335. [2] NASA/JPL/Malin Space Science Systems. [3] HiRISE image McEwen (2008). [4] Malin M.C. et al. (2007) *JGR, 112,* E05S04. [5] Costard et al., (2002); Heldman and Mellon, (2004); Dickson et al., (2007a); Dickson and Head, (2009). [6] Mangold et al. (2008a,b) Workshop on Martian Gullies Abst #8006, AGU Fall Meeting Abst #P34A-02.