EPSC Abstracts
Vol. 5, EPSC2010-511, 2010
European Planetary Science Congress 2010

Stratigraphic relationships and ages of gullies in the northwestern Argyre Basin, Mars.

J. Raack, D. Reiss, H. Hiesinger
Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (jan.raack@uni-muenster.de)

1. Introduction

Stratigraphic investigations revealed that gullies on Mars, first identified by [1], are the most likely evidence for very recent fluvial activities on Mars. Because of the gullies' small surface it is difficult to get reliable ages from crater size-frequency measurements. Our study region, a mountainous terrain located in the northwestern part of Argyre Basin (44°S – 48.5°S and 306°E – 312°E), hosts numerous gullies and glacial features, including a thick dust/ice-rich mantle and viscous flow features [1,2,3]. On the basis of High Resolution Stereo Camera (HRSC) and Context Camera (CTX) imagery, we produced a new morphologic map. We analyzed morphologic units with images of the High Resolution Imaging Science Experiment (HiRISE) and the Context Camera (CTX) to constrain the ages of the formation of gullies in this region.

2. Units

Within the study region, several geomorphologic units have been identified and mapped; three of them were studied in detail to show their stratigraphic relationships to gullies.

2.1 Dust/ice mantle and viscous flow features

The dust/ice mantle is a smooth and flat unit, which occurs in protected depressions or on southern, pole-facing slopes that today receive less insolation. In many cases a sharp boundary to adjacent units is visible. This unit has been interpreted as a young, ice-containing mantle [4]. Viscous flow features were formed when the dust-ice mantle was deformed by creep. Like elsewhere on Mars [5], the viscous flow-features in our study region are mostly located in front of gully aprons.

2.2 Gullies

Some gullies on Mars are very young, possibly less than ~1 Myr [6,7]. They are most likely formed by processes, which require the involvement of liquid water (fluvial and/or debris flow processes) [8]. In the study region gullies mostly occur on the dust/ice mantle and on viscous flow features. On the basis of our detailed map, we found that the gullies only erode into these units but not into the underlying bedrock [2].

2.3 Transverse aeolian ridges (TARs)

Transverse aeolian ridges are a dune form with variable shape. Often these ridges are parallel to each other. The distance between the ridge crests varies between 10 to 100 m; they occur on flat plains, such as valley floors, or in craters, which is in agreement with previous observations of [9].

3. Stratigraphy

The dust-ice mantle covers large parts of the study region as a layer that is draped over the pre-existing topography. In some regions a smooth transition to a modified mantle unit, the dissected mantle, is visible. The occurrence of gullies on the dust/ice mantle and on viscous flow features indicates that the gullies are younger than the mantle. The observed gullies in the study region preferentially occur on N- to E-facing slopes. 65% of all gullies occur on equator-facing slopes and 45% between N and E (Figure 1).

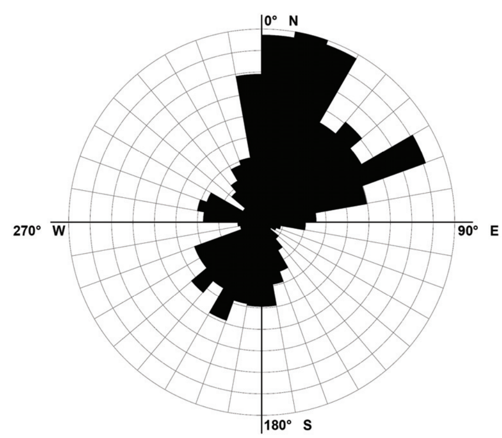

Figure 1: Rose diagram of all gullies in the study region (n=1289).

The orientation of the gullies is consistent with the results of [10], which also show that gullies between 44° and 56° S are preferentially equator-facing. The dust/ice mantle is relative intact on pole-facing slopes. One explanation for this might be that the formation of gullies on equator-facing slopes in these latitudes is related to an increased erosion of the dust/ice mantle caused by enhanced insolation, whereas the sheltered dust/ice mantle on pole-facing slopes remains more intact. There are also differences in the morphology of the gullies: Most of the equator-facing gullies have long and deeply incised channels and small aprons/alcoves; most of the pole-facing gullies have wide and well developed alcoves, relative small channels and commonly large aprons. In the study region, the TAR unit is very young; no craters are visible. Some gully aprons are superposed on dunes, indicating a younger age of these gullies [6]. Small eolian ripples, which overlie both TARs as well as gully fans, were later cut by a small and even younger gully channel, indicating very young fluvial activity (Figure 2).

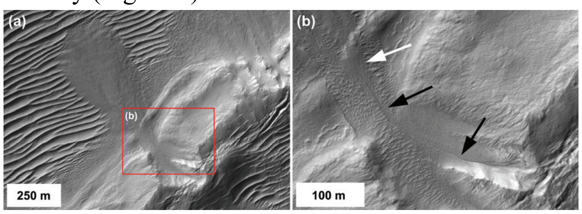

Figure 2: (a) Gully on the edge of a viscous flow feature superposed on a dune field, (b) detail of (a), a young channel cuts through very young ripples (black arrows), the apron (white arrow) shows no ripples (Part of HiRISE-Image PSP_009156_1335).

4. Absolute Ages

Crater size-frequency measurements were used to determine absolute model ages for the dust/ice mantle. The absolute model ages of four different areas are in the range between 5 and 50 Ma (Figure 3). Due to the lack of craters it was not possible to derive absolute model ages for the TARs. However, the lack of craters on this unit implies a very young age.

5. Discussion and Conclusions

On the basis of our map we find that the glaciation in the study region was areally more widespread than previously thought [1]. Today only dissected features and possible leftovers from deposits of an older glaciation are visible in some protected depressions. Our stratigraphic investigation indicates that this glaciation was followed by fluvial activity. Gullies were formed by melting of ice from the dust/ice mantle and viscous flow feature material. The different expositions of the gullies indicate that the dust/ice mantle is mostly eroded on equator-facing slopes due to a higher insolation in these latitudes.

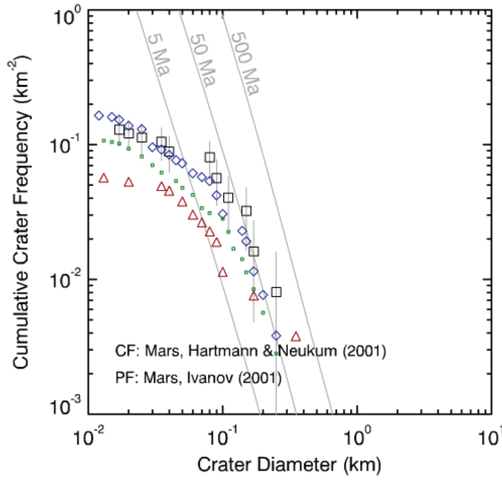

Figure 3: Crater count measurements of four different dust/ice mantle covered areas (black squares, blue diamonds, green dots and red triangles). The approximate ages vary between 5 and 50 Ma.

We have measured approximate model ages of about 5 – 50 Ma for the dust/ice mantle. These are generally younger ages than derived by [1] of about 2.3 – 0.25 Ga and by [11] of about ~0.4 Ga for the glaciation in the Argyre Basin. It is not possible to get absolute model ages for the gullies, but they must be younger than the dust/ice mantle (~5 – 50 Ma) and some of the gullies are younger than the very young TARs (Figure 2). This is in agreement with ages for dune-superposing gullies [6], which show ages younger than 3 Ma, and with the age of a ~1.25 Ma old gully [7] in other regions on Mars. In the study region we can find very young gullies superposing dunes, maybe some of the youngest features in the Argyre Basin. In addition, we find different degradation stages on hill slopes (seen by the different expositions of the gullies) and a relative change from glacial to fluvial activity.

References

[1] Kargel, J. S. and Strom, R. G. (1992) Geology, 20, 3-7. **[2]** Raack, J. et al. (2010) LPSC 41, abstr. 1998. **[3]** Hiesinger, H. and Head, J. W. (2002) PSS, 50, 939-981. **[4]** Mustard, J. F. et al. (2001) Nature, 412, 411-414. **[5]** Milliken, R. E. et al. (2003) JGR, 108, doi:10.1029/2002JE002005. **[6]** Reiss, D. et al. (2004) JGR, 109, doi:10.1029/2004JE002251. **[7]** Schon, S. C. et al. (2009), Geology, 37, 207-210. **[8]** Malin, M. C. and Edgett, K. S. (2000) Science, 288, 2330-2335. **[9]** Wilson, S. A. et al. (2003) LPSC 34, abstr. 1862. **[10]** Heldmann, J. L. and Mellon, M. T. (2004) Icarus, 168, 285-304. **[11]** Banks, M. A. et al. (2008) JGR, 113, doi:10.1029/2007JE002994.