GULLIES AND THEIR RELATIONSHIPS TO THE DUST-ICE MANTLE IN THE NORTHWESTERN ARGYRE BASIN, MARS. J. Raack[1], D. Reiss[1] and H. Hiesinger[1], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, jan.raack@uni-muenster.de

Introduction: We investigated gullies and their relationship to the atmospherically derived dust-ice mantle and aeolian features in the northwestern part of the Argyre basin. We constrained stratigraphic relationships and relative ages of gullies. In addition, we investigated the morphologic characteristics and orientations of all gullies in the study region. Maximum absolute ages for gullies were determined with crater size-frequency distribution measurements of the dust-ice mantle, which is the source material of gullies in the study area [1].

Data: Our investigations are based on Context Camera images (CTX) with an image resolution of ~5 m/pxl and High Resolution Imaging Science Experiment images (HiRISE) with an image resolution between ~25 and ~50 cm/pxl. To define absolute model ages we counted all primary impact craters with the Cratertools software plug-in for ESRI ArcGIS [2]. The absolute model ages were calculated with Craterstats [3] on the basis of the production function of [4] and the chronology function of [5].

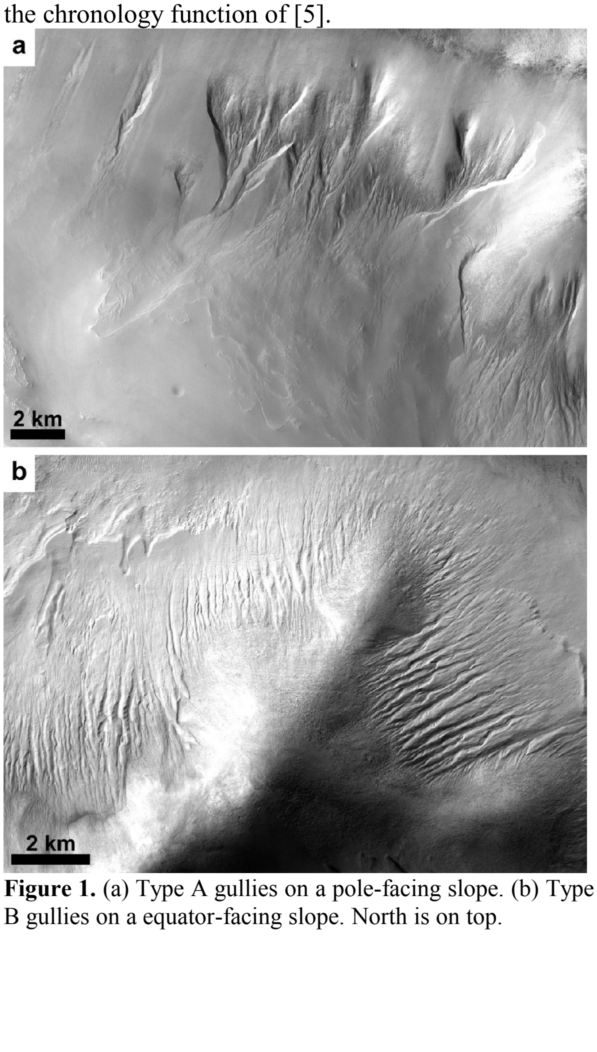

Figure 1. (a) Type A gullies on a pole-facing slope. (b) Type B gullies on a equator-facing slope. North is on top.

Results: *Stratigraphy:* The stratigraphy of the study region is presented in detail by [1]. In the study region gullies emanate from the dust-ice mantle. Aeolian features, such as transverse aeolian ridges (TARs) and large dark dunes (LDSs) are generally the youngest features, but in some areas gullies superpose TARs. On the basis of our investigation it remains unclear whether one of the aeolian units is systematically younger or older than the other aeolian unit.

Gullies: In our study region gullies can be distinguished by two morphologies (Type A and Type B gullies). Type A gullies are characterized by wide alcoves, small channels with respect to the alcove sizes, and well distinct aprons (Fig. 1a). Type B gullies show alcoves, which are coalesced and exhibit longer and wider channels compared to Type A gullies, and sometimes detached aprons (Fig. 1b). Most, but not all of the Type A gullies occur on pole-facing slopes, while Type B gullies are most common on equator-facing slopes (Fig. 2). These results are consisting with results from other investigations in different areas [6-8].

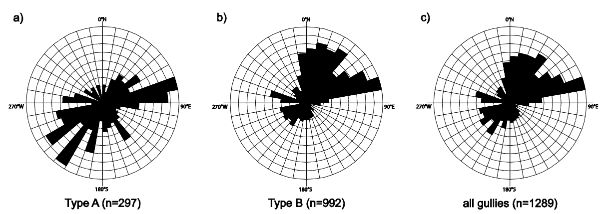

Figure 2. (a-c) Orientations of Type A, Type B and all gullies in the study region.

Ages: The stratigraphic relationships show that some aprons of gullies superpose TARs, indicating a very young age. It was not possible to derive crater size-frequency ages on the TARs because at the spatial resolution of CTX as well as HiRISE images, this aeolian unit is completely uncratered. The fact that gullies emanate only from the dust-ice mantle allows us to derive absolute maximum model ages for gullies by counting craters on the dust-ice mantle, which is older than the gullies.

For our crater size-frequency distribution measurements we selected homogenous flat areas of the dust-ice mantle (~1836 km^2) in CTX images. We excluded areas with sloped surfaces and those that show secondary craters. The derived absolute model age of the dust-ice mantle is ~20 Ma (Fig. 3).

Discussion: The majority of gullies in the study region was incised only into the dust-ice mantle and did not substantially erode the underlying bedrock. Recent gullies, which are also incised into the dust-ice mantle were described in numerous studies [8-14].

The general predominant equatorward orientation of gullies in latitudinal bands between ~40° to ~64°S (within the study region) was also detected by [6-8], and can be explained by differential erosion due to local variations in solar insolation on the slopes resulting in different gully morphologies (Fig.1) [10]. For gullies at similar latitudes as our study region (~46°S), [15] proposed that a phase of gully formation on equator-facing slopes with an age of ~20 Ma or younger, resulted in more degraded gullies. This gully activity was followed by a younger phase of gully formation on pole-facing slopes [15]. Similarly, we find our Type B gullies on equator-facing slopes to be older and more degraded than the Type A gullies, indicating at least two generations of gullies. Alternatively they represent a more rapid degradation of the dust-ice mantle on equator-facing slopes probable caused by higher solar insolation.

For the dust-ice mantle our crater size-frequency measurements yield ages of about ~20 Ma (Fig. 3). Because the gullies are incised into the dust-ice mantle, this age represents the maximum age of the gully formation. The ages of ~20 Ma or younger for gullies are comparable with results of [15], showing also ages of ~20 Ma or younger for gullies elsewhere at the same latitudes.

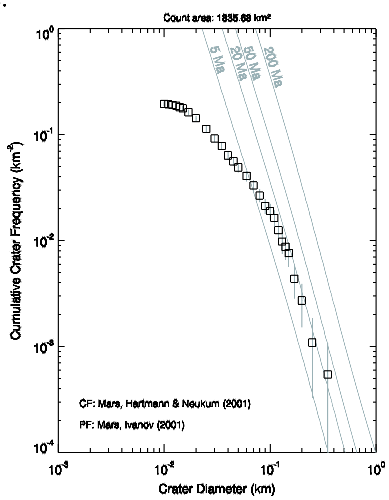

Figure 3. Crater size-frequency measurements of the dust-ice mantle in the study region.

Aeolian units (TARs and LDDs) are generally younger than the dust-ice mantle. The superposition of a few gullies on TARs indicate that some gullies show even younger ages than the TARs. Absolute model ages of young gullies were investigated by [16], who found gully ages younger than ~3 Ma and by [17] who proposed gully ages of ~1.25 Ma. Absolute model ages of TARs at the same latitudinal bands were investigated by [18]. Equatorial TARs have some visible craters and show model ages between ~1-3 Ma, while TARs in southern regions at the same latitudes as our study region exhibit no visible craters (>5-10 m in diameter) [18]. Consequently, [18] assumed that the age of the southern TARs is less than 100 ka. The TARs in our study region exhibit the same features listed by [18]: no visible craters were found, some TARs superpose LDDs (but also LDDs superpose TARs in some areas) and the TARs, which look most recent and young, are near LDD-fields. It is likely that the gullies superposed on TARs are coeval or younger than the TARs. An age of several 100 ka for the TARs and therefore also for the gullies is conceivable. These ages of TARs in our study region are comparable to ages of [16,18]

Conclusions: (1) Gullies in the northwestern Argyre basin form only within the dust-ice mantle. The formation of these gullies is probably due to melting of ice from the dust-ice mantle. The underlying bedrock was not or not substantially eroded.

(2) The gullies show two different morphologies - pristine and degraded - which occur on pole- and equator-facing slopes, respectively. This might indicate different erosion of the dust-ice mantle likely due to variations of sun insolation. We propose that gullies on equator-facing slopes were generated by more extensive/rapid erosion. Alternatively the gullies represent at least two different generations of gullies with older gullies on equator-facing slopes and younger ones on pole-facing slopes.

(3) Crater size-frequency measurements on the dust-ice mantle show an absolute model age of ~20 Ma. Stratigraphic relationships imply that the gullies are younger than ~20 Ma. Because craters on TARs are absent in the northwestern Argyre basin, the superposition of some gullies on TARs indicates an even younger formation of gullies with ages of about several 100 ka,.

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