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Craters and coronae – the influence of volcano-tectonic features on impact crater formation on Venus

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Abstract

This study takes a more detailed look on the types of Venusian tectonic structures affecting polygonal impact crater formation and shows that the surroundings of the Venusian volcano-tectonic features do not actually favour the formation of polygonal impact craters compared to the circular craters. However, the pre-existing structures in the target, caused by volcano-tectonic features, clearly control the orientation of PIC rims when PICs form near these features. As PICs reveal older tectonic features below the surface, this study provide further insight into the tectonic history of Venus and PIC formation.

1. Introduction

Impact craters on Venus, just like on other planets and smaller bodies in the solar system, sometimes display a distinctly polygonal shape rather than being circular or elliptical in plan view [1–8]. Such PICs (polygonal impact craters) are thought to be formed when the dominating heterogeneities in the target, for example faults and fractures, control the formation of craters [3–8]. Thus, also the orientations of the straight crater rim segments are non-random; in many cases the straight rim segments have statistically significant positive correlations with the orientations of various tectonic structures [2].

Earlier [1–2], we established the presence of 121 PICs in the Venusian impact crater population >12 km in diameter. Most of these PICs are shown to be parallel with the structural orientations of the tessera terrain, the rift zones or the concentric components of volcano-tectonic features [2]. We also noticed that in the cases where PICs are located near the volcano-tectonic features, like coronae, the volcano-tectonic features are mostly rather large in diameter, their annuli are clearly visible in topography, and many of them show evidence of a complex, multi-phase formation process [9].

In our on-going study, we are taking a more detailed look on the types of Venusian tectonic structures affecting PIC formation. Some of our key questions are how these effects vary with the type, size, and location of the tectonic structure with respect to the PICs. The study was carried out by using the Magellan SAR (Synthetic Aperture Radar) images (75 m/px), which cover 98% of the surface [10], with additional insight provided by Magellan topographic data (~4640 m/px).

2. Results and discussion

According to our studies, it seems that the surroundings of the volcano-tectonic features do not avour the formation of the polygonal impact craters compared to the circular craters (Figure 1). Approximately 34% of Venusian circular craters and ~31 % of PICs >12 km in diameter are located less than ten crater diameters from the outer edge of the corona-like feature annulus. Correspondingly, ~7% of circular craters and 7% of PICs are situated less than two crater diameters from the corona. However, in the case of PICs which are located close to the coronae or corona-like features, the straight crater rim segments of PICs are usually oriented with the structural orientations of the concentric components of the coronae [2]. In other words, even though the coronae or volcano-tectonic features do not offer exceptionally favourable conditions for PIC formation, in the cases where PICs are formed near the coronae, the most probable reason for the orientation of the straight rim segments are the pre-existing structural conditions caused by the nearby volcano-tectonic feature.

The complex and problematic nature of the PIC formation process is emphasized by the observation that there are also circular craters in the vicinity of a

corona–PIC pair. There can be, however, several possible explanations for the different morphologic appearance of the craters. Firstly, the surroundings of the volcano-tectonic features most probably are not homogeneous. This is supported by the fact that in most of the observed cases the PICs and the circular craters appear to be located quite far from each other. Also, there may be notable differences in cratering processes or age and size of the craters. These questions will be studied in greater detail in the future, which may help to clarify the conditions which favour the formation of PICs.

Another interesting topic of the future work will be the study of the PICs which do not show any correlations with the visible tectonics, or which are located a relatively featureless surface, like on plains. According to our assumption, these PICs can be utilised to evaluate the orientation of hidden tectonic structures under the lava plains, which would provide further insight into the tectonic history of Venus and PIC formation.

3. Conclusions

The surroundings of the volcano-tectonic features do not seem to be more favourable for the formation of the polygonal impact craters compared to the circular craters – actually both types of craters are equally common in their vicinity. However, when PICs are formed near coronae or other volcano-tectonic features, the dominating fractures of the target material caused by this feature control the orientations of PIC rims.

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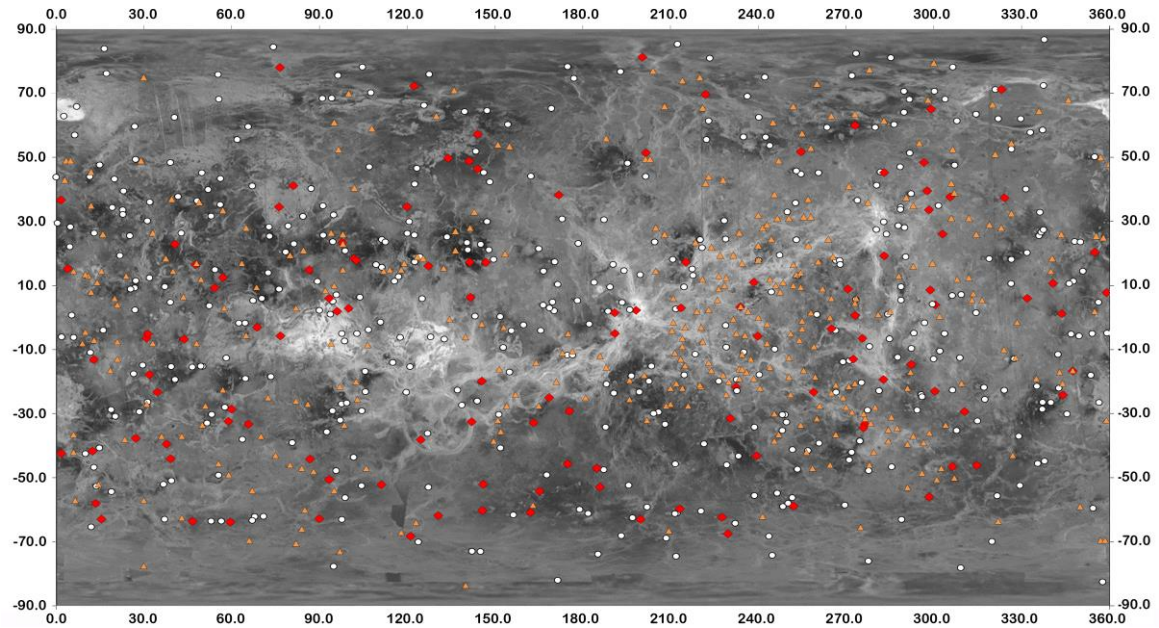

Figure 1: The distribution of Venusian coronae (orange triangles) with circular (white dots) and polygonal (red diamonds) impact craters (D>12 km) plotted on Magellan data. Approximately 34% of Venusian circular craters and ~31 % of PICs (D>12 km) are located less than ten crater diameters from a corona-like feature so the coronae do not seem to be more favorable for the formation of the PICs compared to the circular craters.