AN UPDATE ON THE STRUCTURAL CONTROL OF VENUSIAN POLYGONAL IMPACT CRATERS.

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Introduction: Impact craters on Venus, just like on the other planets and smaller bodies in the solar system, sometimes display a distinctly polygonal shape in plan view [1–8]. The formation of such polygonal impact craters (PICs) is controlled by pre-existing tectonic structures, for example faults and fractures. However, their exact formation mechanisms are still not entirely clear [3–8].

Earlier [1–2], we established the presence of 121 PICs in the Venusian impact crater population >12 km in diameter with non-random orientations of the straight crater rim segments: the rim segment orientations were shown to be parallel with various tectonic structures [2]. They correlate most strongly with the structural orientations of the tessera terrain, the rift zones, and the concentric components of volcano-tectonic features [2] (Figure 1). The volcano-tectonic features with nearby PICs 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].

Several previous studies, ours included, have addressed the problematics of PICs and the pre-existing target structures with emphasis on impact cratering mechanics and crater morphology [3–8]. We have also established how various tectonic structures have different effects on the subsequently forming impact craters, or no observable effects at all [2, 4]. In our on-going study, we are taking a more detailed look on the types of Venusian tectonic structures affecting PIC formation. Some of the key questions are how these effects vary with the type, size, and location of the tectonic structure with respect to the PICs. As PICs can reveal older tectonic features below the surface, our new case studies may provide further insight into the tectonic history of Venus and PIC formation.

The study was carried out by using the Magellan SAR (Synthetic Aperture Radar) images, which cover 98% of the surface [10], with additional insight provided by Magellan topographic data.

Preliminary results and discussion: According to our preliminary studies, the surroundings of the volcano-tectonic features do not seem to “favor” the formation of the polygonal impact craters compared to the circular craters (Figure 2). Approximately 34% of Venusian circular craters and ~31 % of PICs (D>12 km) are located less than ten crater diameters from a volcano-tectonic feature. Correspondingly, ~7% of circular and 7% of PICs are situated 2–10 crater diameters from the corona. However, in the case of PICs which are located close to the coronae or corona-like features, we do see a strong correlation between the structural orientations of the concentric components of the coronae and the orientations of the straight crater

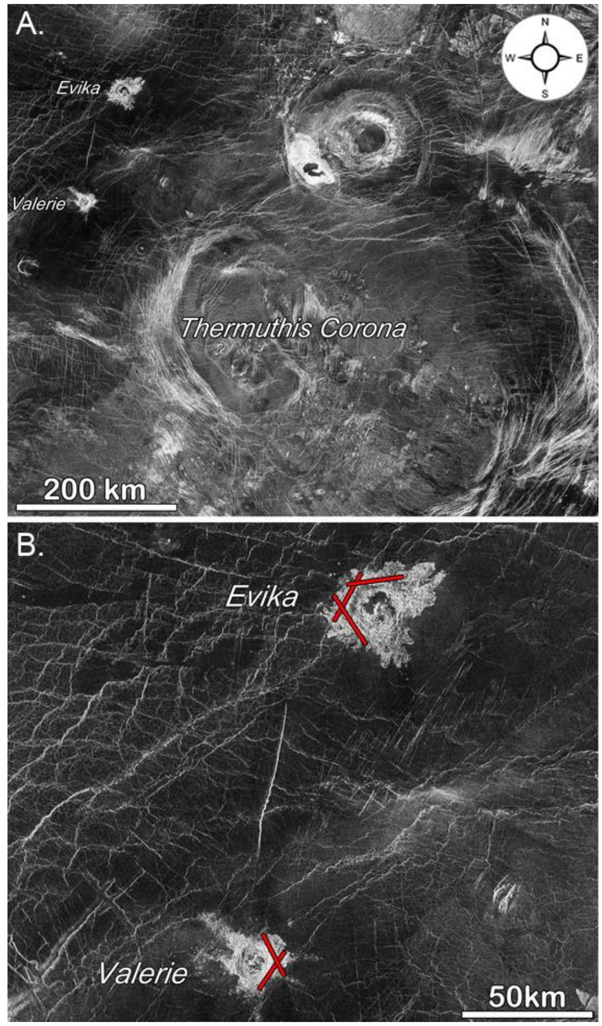

Figure 1. A) A Magellan left-looking SAR image shows two PICs, Valerie (6.4°S, 30.9°E, D=13.6km) and Evika, (5.1°S, 31.430.9°E, D=20.3km) which are located close to Thermuthis Corona (D=330km). B) A detail image shows the craters’ straight rim segments which are now parallel both to the radial (Valerie) and concentric (Evika) components of Thermuthis.

rim segments [2]. Thus, the coronae and volcano-tectonic features do not offer exceptionally favorable conditions for PIC formation, but when PICs are formed near the coronae, we can easily identify the most probable reason for the orientation of the straight rim segments to be 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 differing morphologic appearances of the craters. Firstly, the surroundings of the volcano-tectonic features most probably are not homogeneous. Moreover, the PICs and the circular craters appear to be located quite far from each others in most of the observed cases. Also, there may be notable differences in the ages and sizes of the craters. These questions should be, however, studied in greater detail in the future, which may help to clarify the conditions that “favor” the formation of PICs.

A similar positive correlation of the straight rim segments of PICs and distinguishable tectonics apply also for the PICs that are located close to the rift zones [2]. In spite of these correlations, large numbers of PICs do not show similar correlations with the visible tectonics, or they are located on plains – a relatively featureless surface. The interesting topic of future studies is to find out if these PICs can be utilized to evaluate the orientation of hidden tectonic structures under the lava plains.

Conclusions: The surroundings of the volcano-tectonic features do not seem to be more favorable for the formation of the polygonal impact craters compared to the circular craters – both types of craters are equally common in their vicinity. However, when PICs are formed near the coronae or other volcano-tectonic features, the PIC rims are oriented parallel to the pre-existing structures caused by these volcano-tectonic features.

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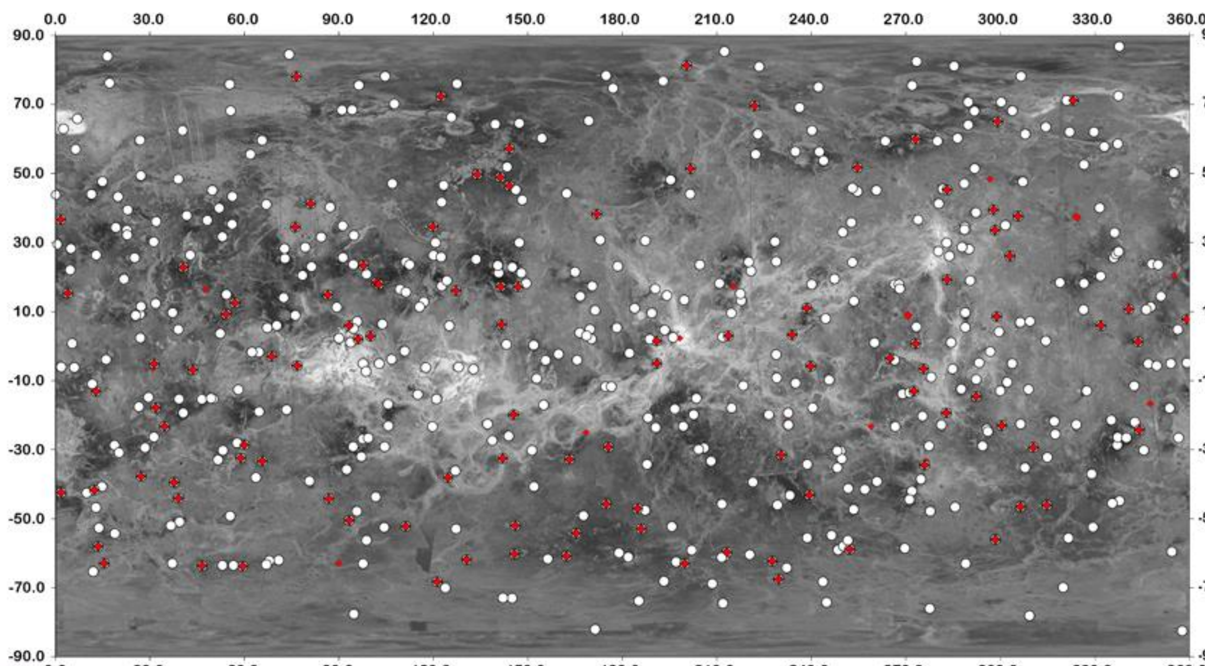

Figure 2. The distribution of Venusian circular (white dots) and polygonal (red diamonds) impact craters (D>12 km) plotted on Magellan data. Both crater distributions are relatively regular, without showing evidence of significant clusters [see 1].