THE ASSOCIATION OF VENUSIAN POLYGONAL IMPACT CRATERS WITH SURROUNDING TECTONIC STRUCTURES. M. Aittola[1], T. Öhman[1,2], J.J. Leitner[1,3], J. Raitala[1], V.-P. Kostama[1], and T. Törmänen[1]. [1]Department of Physical Sciences, University of Oulu, Finland, [2]Department of Geosciences, University of Oulu, Finland, [3]Institute for Astronomy, University of Vienna, Austria. (marko.aittola@oulu.fi).

Introduction: The Solar System hosts numerous impact craters whose shape in plan view is more or less angular instead of being circular or ellipsoidal. They can be found on all terrestrial planets and also on many icy moons as well as asteroids [1,2]. These craters are called Polygonal Impact Craters (PICs). Thus, they are rather common on bodies that have craters and fractured crusts [e.g. 3,4,5], including Venus [6; see example in Fig. 1]. The available data sets limit the interpretation of the Venusian PICs, but our updated catalogue includes 121 impact craters (Fig. 2), which show at least two adjacent straight rim segments. This number includes only the craters larger than 12 kilometers due to the uncertainties caused by the resolution of the Magellan data.

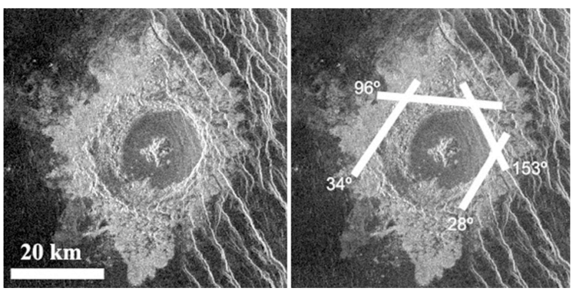

Fig.1. An example of an impact crater with more than one straight rim segment. The image pair shows the Behn crater, situated at 32.5S/142E (Magellan left-looking radar image), with the measured straight rim segments.

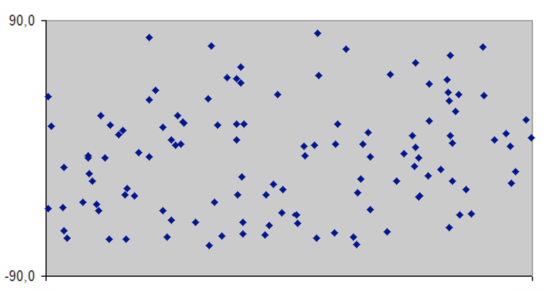

Fig. 2 The distribution of polygonal impact craters (diameter > 12 km) on Venus.

Background: The comparison of PICs and "normal"-shaped craters by using different characteristics (diameter, altitude, geologic setting, morphologic class, floor reflectance, degradation state, and wall terracing) showed that the only characteristics, which make difference between normal- and polygonal impact craters are the diameter and the intimately related morphologic class [6]. It was obvious that relative abundance of polygonal impact craters increases among the smaller craters compared to larger craters. Thus, it seems evident that the smaller crater sizes favor the formation of straight rim segments, but otherwise these craters show similar characteristics to other craters.

There is not a large population of impact craters on Venus like there is on Mars, so we cannot use a statistically reliable population of PICs on Venus to determine their correlation with the local tectonics. However, our earlier study [6] showed that there are regions where the straight segments of the crater rims most clearly follow the orientations of the dominant tectonic features of the area, indicating a possible correlation between crater formation and tectonics around the crater. Thus, the orientations of crater walls may reflect – at least in some places - the local tectonics and zones of weakness also on Venus and could thus tell us about the directions and distributions of fractures or other zones of weakness in the crust, just as in the case of Mars [3-5].

In this study we explored if there can be found correlations between the straight walls of the PICs and the surrounding tectonics by analyzing all the tectonic features and their orientations around the polygonal craters. In addition, we wanted to find out if the type of the tectonics or their distance from the craters affect these correlations. We also declared if the size of the impact craters would have some influence to possible correlations between the tectonics and straight walls of the PICs.

Data and methods: The study was done by using the Magellan SAR images, which cover 98% of the surface [7]. For the analysis and measurements we used the full-resolution mosaicked image data with 75 m/pixel size. For the mapping we used compressed once mosaicked image data records (C1-MIDRs) with a resolution of 225 m/pixel. We have used also the altimetry data together with the SAR data, especially when mapping the example areas.

To measure the straight walls of the PICs, we selected the most obvious cases. Therefore, the original amount of PICs (131; [6]) was reduced to 121 for this study. From the polygonal impact craters we measured all the straight walls and from the surroundings we measured the orientations of the tectonic structures. We divided tectonic features to several different categories and also made the division based on the distance from the crater. Thus we gathered following information from the surrounding tectonic features: Type, orientation and the distance from the crater. Due to the nature of the Magellan radar data (left- and right –looking directions), we ignored all the East-West orientated features (±15°). That is because they are so difficult to define and it would be impossible to avoid uncertainties. When comparing the measurements of the orientations, we interpreted as parallel those which difference is less than ±7.5°.

After considering the limitations mentioned above, we measured orientations of the PICs straight walls as well as all the surrounding tectonic features. The measured tectonic features included young rift zones, old rift zones, wrinkle ridges on plains, mountains belts, lineaments (not identifiable, single features), structures associated to tessera terrains, and tectonic features associated to volcano-tectonic features - usually annulus of corona or arachnoids (from coronae and arachnoids we measured both concentric and radial orientations of the structures compared to PICs). Moreover, all these categories were subdivided on the basis of the distance from the crater in to two classes: Those which are situated less than 2 crater diameter from the PIC and those which are 2-10 crater diameter away from the PIC.

Results: Our measurements display that especially young rift zones, tessera terrains, and the concentric component of the corona/arachnoid show strong correlations (parallel orientations) with the straight walls of the polygonal impact craters (example in Fig. 3). Furthermore, the correlations are systematically better when the tectonic features are close to the craters. The third finding was that the wrinkle ridges in volcanic plains show no clear correlation with PICs, even though we can measure several different orientations for the ridges. According to our measurements, the crater sizes do not affect the correlations mentioned above, although the smaller crater sizes seem to favor the formation of straight rim segments.

Thus, previous studies have shown that there are polygonal impact craters on Venus and the smaller crater sizes do favor the formation of straight rim segments for some reason. The results of this study - the straight rim segments of the craters show clear correlations with certain tectonic features, especially when they are situated close to the crater – indicate that the crater formation process reflects the existing planes of weakness and/or fractures in the target material, just like in the case of Mars. Therefore, these craters can actually be a good tool when analyzing the tectonics hidden beneath the Venusian surface.

References: [1] Porco C.C. et al. (2005) *Science 307*, 1237. [2] Prockter L. et al. (2002) *Icarus 155*, 75 [3] Öhman T. et al. (2006) *MAPS* 41:1163-1173 [4] Öhman T. et al. (2005) *Impact Tectonics* ed by C. Koeberl, H. Henkel, p. 131. [5] Öhman T. (2007) *Licentiate Thesis*, University of Oulu. [6] Aittola M. et al. (2007), *Earth, Moon and Planets* 101: 41-53 [7] Ford J.P. and Plaut J.J. (1993) in *Guide to Magellan Image Interpretation*. JPL Publication 93-24 p. 7.

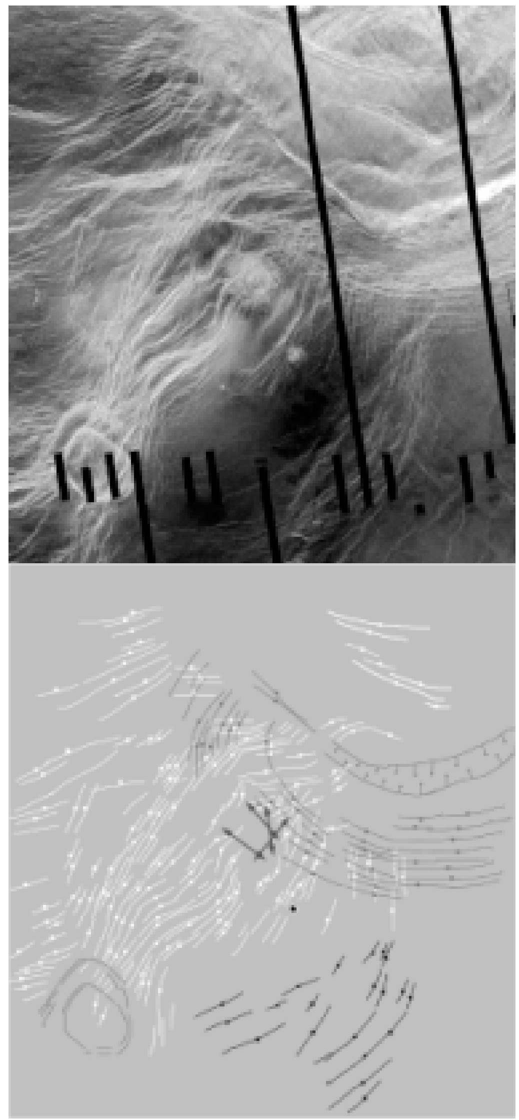

Fig. 3. Image pair, which shows the tectonic surroundings of the Austen crater. The sketch map in the lower image displays the orientations of he straight walls of the impact crater (arrows) and their parallel orientations with the rifts (white lines) and the concentric structures of the corona feature (grey lines).