SPACING OF STRUCTURES IN THE RIFT- AND GROOVE BELT-RELATED CORONAE ON VENUS,
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Introduction: Coronae are unique class of structures that were discovered during analysis of data from Venera-15/16 mission [1,2]. The defining element of coronae is their circular rim that consists of either ridges or grooves. In the images taken by Venera-15/16 (~1/4 of the surface of Venus), most of coronae appear to have ridged rim. After Magellan mission it became evident, however, that rims of the vast majority of coronae consist of swarms of densely packed grooves [e.g. 3]. There is a consensus that coronae are the surface manifestations of diapirs at different stages of evolution [4]. After Magellan, coronae were classified and listed in different catalogues [3,5]. In the first catalogue [3], which was used in this study, there are 407 coronae. About 21% of them associate with large volcanoes, 68% of coronae occur either near rift zones (RZ) or groove belts (GB), and 11% of the structures associate with individual fractures within plains [4]. This type of association and the dominance of grooves within the rims suggest that coronae are linked to the tensional tectonics. Rift zones and groove belts are the major belts of extensional structures that appear to form at distinctly different epochs of the geologic history of Venus (groove belts are older) [6]. The systematically smaller spacing of structures characterizes groove belts (1.2 km in groove belts, GB, vs. 1.7 km in rift zones, RZ) [7]. This difference was interpreted as an indicator of progressive thickening of lithosphere from the epoch of groove belts formation to the time of rift zones formation [7,8]. Does the spacing of grooves in the rims of coronae associated either with rifts or groove belts follow the same trend? The goal of this study was to estimate the mean spacing and frequency distribution of the spacing values for the structures in the rims of coronae associated with the different types of extensional zones.

Method and results: The catalogue of coronae [3] and the global geological map of Venus [9] were used to outline two subpopulations: (1) coronae that spatially associate with groove belts (GB_COR) and (2) coronae that spatially associate with rift zones (RZ_COR). In these populations, coronae that (A) appear to be synchronous of younger than RZ or coronae that (B) appear to be synchronous of older than GB were selected. The following criteria were used to construct these groups. Group A: (1) structures of a corona and a rift zone mutually cut each other and (2) structures of a corona and lava flows from it cut/embay graben of a rift zone. Group B: (1) a corona is cut by structures of a groove belt and (2) corona rim is either partially or completely formed by branches of a groove belt. The coronae from group A typically postdate regional plains (rp) and the coronae from group B predate the plains. Thus, these groups display not only two different types of association of coronae and belts of extensional structures but also correspond to distinctly different ages. Group A represents relatively young coronae and group B consists of older structures.

Ten percent of coronae from each group were selected at random for the study. The measurements of the spacing were made along profiles that cross the rim of each corona in two locations on both sides of the corona. The mean spacing of grooves on the rims of the rift-related coronae (Group A, RZ_COR) is about 1295 m and the mean spacing for the groove belt-related coronae (Group B, GB_COR) is about 999 m. Although the means are close to each other and the distributions of spacing values are overlap each other significantly, the values of spacing for the group B are noticeable shifted toward smaller values (Fig. 1).

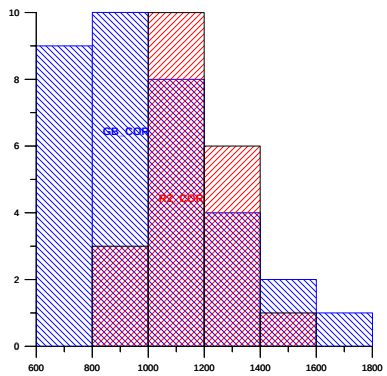

Fig. 1. Histogram of the spacing values for coronae associated with rifts (red) and groove belts (blue)

If one to compare spacing of structures in corona rims with the spacing of graben within rift zones, it is evident that the values for both groups of coronae are systematically smaller and the histogram is bimodal (Fig. 2). In contrast, the spacing values in both groups of coronae practically coincide with the distribution of spacing within groove belts (Fig. 3).

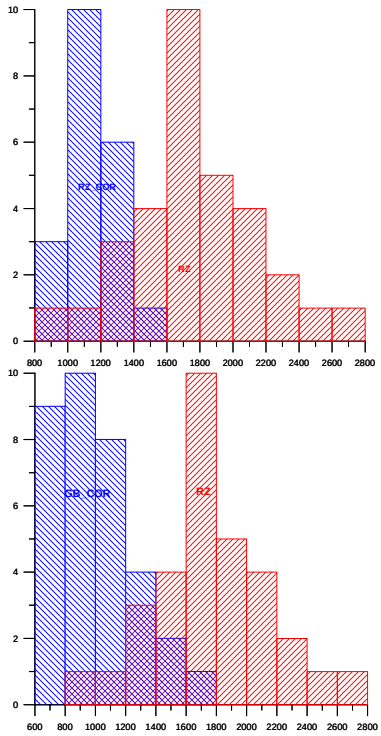

Fig. 2. Histogram of the spacing values for coronae of groups A and B (blue) and rift zones (red)

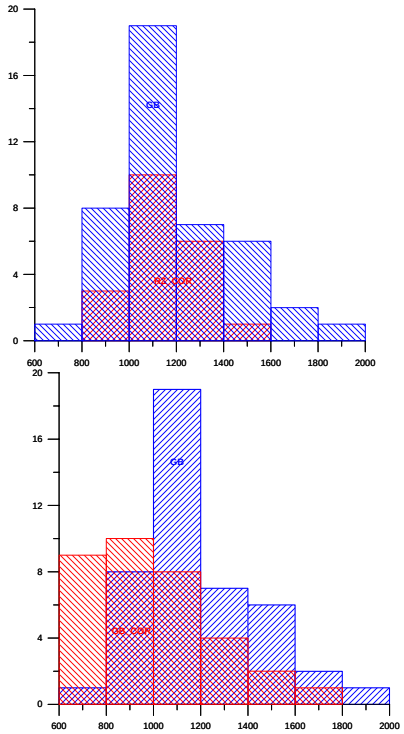

Fig. 3. Histogram of the spacing values for coronae of groups A and B (blue) and groove belts (red).

Discussion and conclusions: The spacing values apparently reflect environments of formation of structures (the thickness of the deformed layer, deformation rate, thermal conditions during formation, etc.). Because the characteristic spacing of graben in rift zones is systematically larger than the spacing of structures in groove belts [7] it was expected that the rift-related coronae would display less densely packed structures in their rims if the parent diapirs for these coronae deformed the thicker rheological barrier of the lithosphere. There is a little evidence for such a difference, however (Fig. 1). Two hypotheses may explain this. (1) The coronae that spatially associate with rift zones began to form earlier in the environment of the thinner lithosphere but continued to evolve and their late features (tectonic structures and/or lava flows) formed contemporaneously with the majority of structures in rift zones. Due to this, a corona could be classified as belonging to the group of younger structures but the measured spacing values could be related to the earlier episodes of the corona evolution. (2) Rift zones closely associate with the major dome-shaped rises, formation of which is likely related to the large and deep diapirs perhaps originated at the core/mantle boundary [10,11]. These deep diapirs deformed the thicker lithosphere that resulted in formation of the large and relatively sparsely spaced graben collected into rift zones. The rift-associated coronae may be related to the daughter diapirs spawned by the larger ones [12]. In this case, the smaller secondary diapirs could originate within the lithosphere and deform a relatively thin layer. The thermal effect of these diapirs may change properties of the deformed layer (made it more ductile), which also may lead to the finer spacing of structure in the rims of the rift-related coronae.

References: 1) Barsukov, V.L. et al., *JGR*, 91, D411, 1986; 2) Pronin, A.A. and E.R. Stofan, *Icarus*, 87, 474, 1990; 3) Stofan, E. R., et al., *JGR*, 97, 13378, 1992; 4) Smrekar, S.E. and E.R. Stofan, *Science*, 277, 1294, 1997; 5) Crumpler, L. S. and J. Aubele, in: *Encyclopedia of Volcanoes*, 770, 2000; 6) Basilevsky, A. T. and J.W. Head, *JGR*, 103, 1998; 7) Guseva, *Vernadsky- Brown*, 48, 2008; 8) Mastrapa, R., *LPSC 28*, #1756, 1997; 9) Ivanov, M.A., *LPSC 39*, #1017, 2008; 10) Jellinek, A. M., et al., *GRL*, 29, 10.1029/2001GL014624, 2002; 11) Johnson, C.L. and M.A. Richards, *JGR*, 108, 10.1029/2002JE001962, 2003; 12) Hansen, V. L., *GSAB*, 114, 848, 2002.