TWO DIFFERENT TYPES OF RIFT ZONES OF VENUS: RIFT VALLEYS AND BELTS OF GRABEN.

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Introduction. The area of rift zones (rz) on the Global geological map of Venus (scale 1:12 M) is ~ 5% [1]. Rifts are spatially distributed mainly in the equatorial region of the planet [2-3; 1] and extend to 40,000 км [4-6]. The rifts are spatially associated with lava plains [7] and large volcanoes [8-9]. The highest concentration of these volcanoes observed in the regions of triple junction of rift zones [10] – in the BAT (Beta-Atla-Themis) region, where these volcanoes are associated with significant positive gravity anomalies [11].

Goals of the study: to classify varieties of rifts by the types of the rift-forming structures and study their spatial distribution, topographic configuration, morphometric parameters, and character of volcanism associated with the rifts varieties.

Results: The rift zones distributed on the surface of Venus in the region between ~ 30°N-30°S and ~ 120°-315°E and form broad zones of grabens and troughs that cross all complexes excluding the some youngest lava plains. Topographic features of rifts allow distinguishing within them two structural types: «rift valleys» and «belts of graben».

***Rift valleys*:** a) structures of this type form long (thousand of km) and wide (hundreds of km) zones [12] and expressed topographically as deep (several km) canyons; b) structures are spatially associated with domes-shaped rises of the BAT region [4; 6-7], which classified as the rift domes [9-10] and characterized by the rising of hot mantle material [5; 13-15; 8-9]; c) structures (canyons) are typically radiating away from the top of the rises and spatially associated with broad lava plains (hundreds of km across) [7; 16] and with large volcanoes (D>100 km [17]) [8].

Canyons of the Atla Regio located in the region between ~ 0º-25ºN and ~ 180º-210ºE. The Atla Regio is characterized by the presence of a large dome ~ 1200-1600 km wide and ~ 2.5 km high [8], from the top of which propagate the canyons in the NW, SW and SE directions extending up to 3500 km. The canyons have a W-shaped profile in a cross-section (Fig.1). The average width of the canyons is: ~ 171±66 km for NW rift, ~ 386±76 km for SW rift, and ~ 250±75 km for SE rift. The average visible depth of the canyons is: 2.6±1.4, 1.5±0.3 and 1.8±0.8 km for the NW, SW, and SE rifts, correspondingly. The canyons of the Atla Regio are spatially associated with lava plains [7; 17] and with large volcanoes of Maat (height - H ~ 5.9 km, D ~ 342 km, V ~ 202.3×10³ km³) and Ozza (H ~ 2.6 km, D ~ 348 km, V ~ 91×10³ km³) Montes. The radial flows from the Maat and Ozza Montes are extending up to 600 km and 800 km respectively. Perhaps a modern active volcanism in the Atla Regio continues today, its features are fixed CA «Venus Express» (VMC-Venus Monitoring camera) [18].

Canyons of the Beta Regio located in the region between ~ 25º-50ºN and ~ 180º-210º E. The canyon of Devana Chasma propagates from the Beta region to the south and reaches the Phoebe Region. The Beta region is characterized by a large dome ~2500 km wide [13; 8; 15] and from 2 to 5 km high [8; 13], from the top of which propagate canyons in the NW, SW and S directions and extend to 2600 km; S rift of the Beta - Devana Chasma merges with Phoebe region. The canyons have a W-shaped profile in a cross-section (Fig. 2). The average width of the canyons is: 191±73,182±70 and 236±109 km for NW, SW and S rifts, correspondingly. The average visible depth of canyons is: ~ 2.0±0.9, 1.5±0.5 and 2.0±1.1 km for NW, SW and S rifts. The canyons of the Beta region are spatially associated with broad lava plains [7; 16] and with large volcano of Theia Mons (H ~ 3 km, D ~ 228 km, V ~ 160×10³ km³) [8; 15]. The radial flows from the Theia Mons extend up to 1000 km. Results of geophysical modeling of the structure of lithosphere suggest that Beta may be currently rising [19].

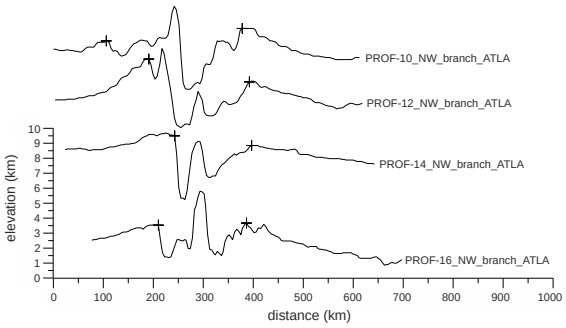

Fig.1. The canyon of the Atla Regio (NW rift zone).

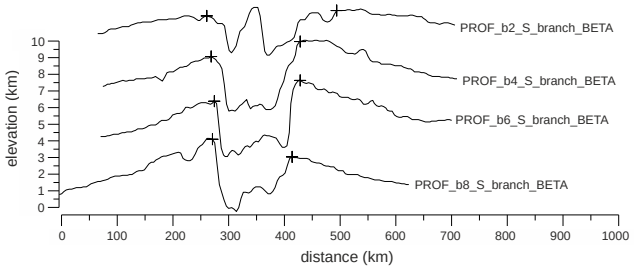

Fig. 2. The canyon of the Beta Regio (S rift zone).

Belts of graben: a) structures within this type of rifts are localized in extended (thousand km) and wide (hundreds of km) linear zones, morphologically manifested as a series of closely spaced grabens; b) these structures do not show the spatial association with dome-shaped rises and are more widespread than the rift valleys. As an example below is a description of the most extended of the belts of graben to the west of the BAT region.

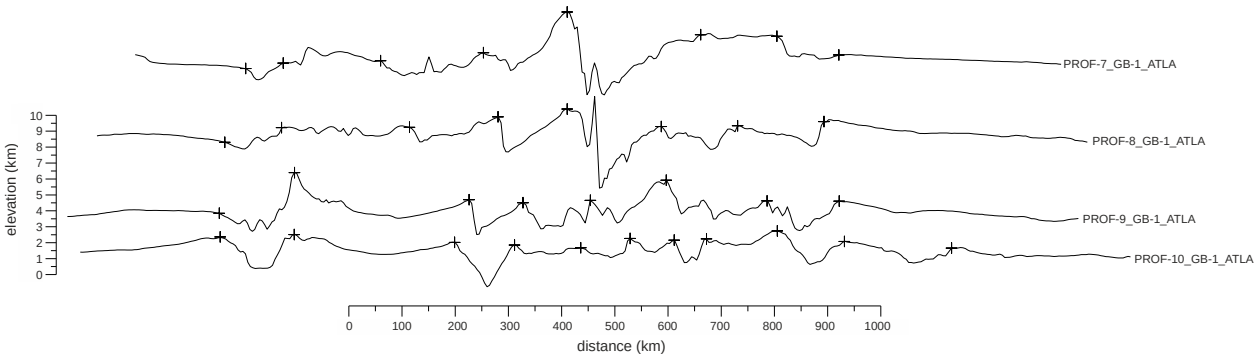

Fig. 3. Belt of grabens at the end of the Atla Regio.

Belt of grabens of the Atla-Aphrodite-Thetis-Ovda: extends from the Atla Regio toward the Aphrodite Terra through Thetis Regio and ends at the tessera massif in Ovda Regio. The total length of the belt ~ 11000 km, its width varies ~ from 500 to 1500 km, visible depth from 1.7 to 4.2 km. Topographic profile of the belt as a whole is flat, complicated by numerous grabens, alternating with horsts (elevated relative to the surrounding area) (Fig.3). The average width of the belt grabens ~ 169±68 km, average visible depth ~ 2.3±1.6 km. The average width of the horsts is ~ 250±108 km, their average height (relative to a base of the belt of grabens) ~ 3.2±1.7 km. The belt of grabens are spatially associated with lobate lava plains. The flows of lava plains are extend from individual fractures/grabens and can reach ~ 500 km. The large volcanoes do not associated with this belt of grabens. As an example, below is a description of the part of studied belt of grabens – Thetis Regio.

Belt of grabens of the Thetis Regio located in the region between ~ 0º-25ºS and 120º-150º E. The Thetis Regio is strongly tectonically deformed and includes the rift zones of the Vir-ava Chasma, Quilla Chasma and Diana Chasma. The rift fractures are localized in the extended ~ 3500 km and broad ~ 500-700 km belt of grabens NE-SW trending. The belt of grabens of Thetis Regio in a cross-section is relatively flat with shallow topographic details, corresponding of individual grabens and horsts between them. This belt is spatially associated with lobate lava plains extending up to 500 km and is not associated with the large volcanoes. The process of rifting in Thetis region manifested in late stage of geological history of Venus, and perhaps may be currently active [20].

Conclusions: The differences of the two studied structural types: «rift valleys» and «belts of graben» manifested in the following features: (1) by the character of spatial distribution of the rift valleys – less common and more concentrated comparing to the belt of grabens, which form more extensive and wider zones; (2) canyons are closely connected with domes and spread out from their tops, the belts of graben are observed mainly outside the domes; (3) the rift valleys are presented by individual deep canyons, while profiles of the belts of graben, are generally, flat; (4) the rift valleys are spatially associated with large volcanoes, which are not in spatial association with the belts of graben [16], the belts of graben are characterized by abundant fracture eruptions . The both structural types represent different facies of zones of extension and formed in late Atlian period of geological history of Venus [21]. Perhaps, the rift valleys and associated volcanism can be shifted to the top of the tectonic evolution of the volcanic system, while the belt of graben and associated lava flows – to the earlier phases of evolution.

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