COMPARISON OF MORPHOMETRIC PARAMETERS OF THE RIFT-ASSOCIATED VOLCANOES OF VENUS AND EARTH. E.N. Guseva, Vernadsky Institute of Geochemistry and Analytical Chemistry of Russian Academy of Sciences, Moscow, Russia, guseva@geokhi.ru

Introduction: Many of the large volcanic edifices of Venus (D > 100 km) [1] are spatially associated with rift zones [2; 3] and located in the regions of the rift triple junctions [4]. The highest concentrations of volcanic edifices are observed in the region of BAT (Beta-Atla-Themis), which is characterized by significant positive gravity anomalies [5; 2]. Extension, lateral dimensions, and structure of rift zones of Venus and Earth [6-13] suggest that these zones are related to similar geodynamic environments on both planets.

The composition of volcanic products on Venus is largely basaltic and likely corresponds to the terrestrial lavas of tholeiitic series rocks and, to a lesser degree, to alkaline basalts [14]. Rock compositionally similar to rhyolites, granites, monzonites, leucites, syenites and lamprophyres may occur on Venus [14] but morphologic characteristics of landforms suggest that these compositions may be exotic on the planet and basaltic lavas with low viscosity dominated the surface rocks [15]. By the analogues to the tholeiitic series, it can be assumed that the parent melts of these rocks were the high-temperature and dry magmas with low or medium volatile content [16].

The volcanic edifices of the central type of the Earth are also often associated with large continental rifts, for example, in East African Rift System (EARS) [17]. The lithosphere near the EARS is characterized by the presence of thermal and seismic anomalies [18; 19]. The composition of volcanic products in the EARS, is mostly basaltic and vary from moderately alkaline K-Na magmas in the Eastern rift branch to ultrapotassic in the Western rift branch [20]. These magmas are enriched in volatile components, mainly H_2O и CO_2 [21] and their eruptions is resulted in deposition of alkaline basalts, basanites, mudzhierity, phonolites, tephrites [20].

The purpose of the study was the comparison of quantitative characteristics of volcanic constructs (height, diameter, height to diameter ratio and volumes of volcanic edifices) that are spatially associated with large rift zones on Venus and Earth (specifically, the EARS) in order to emphasize the similarities and differences of the large scale extensional provinces on both planets.

Observations and results: Thirteen large volcanoes on Venus were analyzed: Theia, Maat, Ozza, Gula, Innini, Hathor, Uretsete, Polik-mana, Olesnicka, Mem Loimis, Yunya-mana, Justitia Tholus, Udunn. The topographic configuration of these edifices was assessed with the help of topographic profiles that pass through the volcano summits and oriented in different direction. The Theia volcano has an irregular shape (its volume was not estimated), because the volcano is in the center of a triple junction of rift branches in Beta Regio. The shape of the volcano is strongly affected by mutual processes of updoming and rifting in this region [22]. The other studied volcanoes of Venus have the shape of cones or truncated cones. Their heights vary from 0.9 to 5.9 km, diameters are ranging from 89 to 410 km, and the height/diameter ratio, K, is from 0.004 to 0.023. As the diameter of the volcanoes increases, the value of K decreases (Fig.1). The volumes of the Venusian volcanoes are estimated to vary from 5.8×10^3 to 202.3×10^3 km^3.

Fifty-three analyzed large volcanoes (26 of them are from the catalogue [23]) of the EARS are located either on the rift flanks (e.g., Zuqualla, Ol Doinyo Lengai), or directly within the rift valley (e.g., Kitumbeine, Gelai). The topographic shape of the volcanoes was also estimated with the help of topographic profiles. The analyzed volcanoes usually have the shape of truncated cones and less frequently they have either conical or irregular shape. The heights of the volcanoes vary from ~0.4 to 4.8 km, diameters are ranging from ~4 to 107 km, and the value of K is from 0.03 to 0.24. As in the case of Venus, the value of K of the terrestrial volcanoes decreases with the increase of their diameters (Fig.1). The volumes of the well preserved (non-eroded) terrestrial volcanic edifices vary from ~0.002×10^3 km^3 to ~10.4×10^3 km^3.

Conclusions: The plot of the values of K vs. the edifice diameter (Fig.1) shows that the studied volcanoes of Venus and Earth form two distinct groups: the Venusian edifices are characterized by larger diameters and the smaller height to diameter ratios and have the general shape of the flattened cones with very shallow slopes on their flanks.

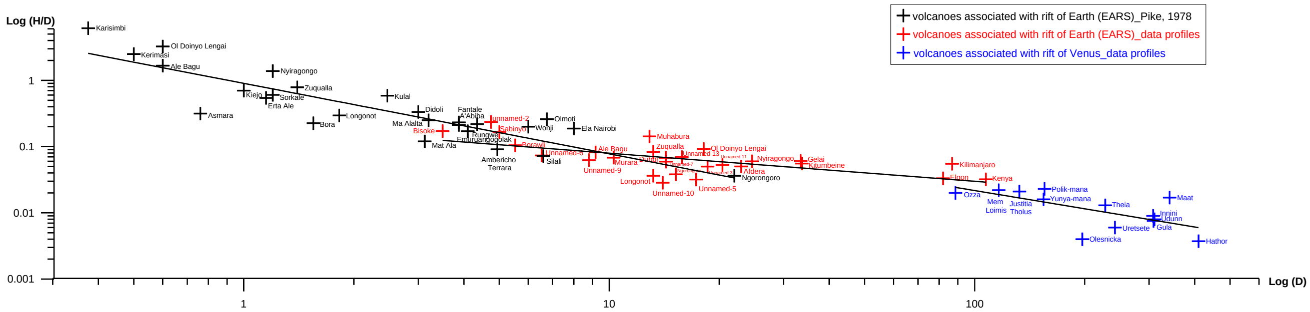

Fig.1. Relationships between the value K (y-axis) to the edifice diameter (x-axis) for the studied volcanoes of Venus and Earth (EARS).

Terrestrial volcanic edifices are characteristically smaller, show the larger height to diameter ratios and are characterized by significantly steeper flanks (stratovolcanoes). The noticeable exclusions from the group of terrestrial volcanoes are the edifices of Kilimanjaro, Kenya, and Elgon volcanoes. They are located on the flanks of the Kenya rift and their morphometric characteristics are closer to those of the Venusian volcanoes (Fig.1).

Estimates of the volume of large volcanoes of Venus are consistent with the literature data (for example, [24]) and an order of magnitude larger than the volume of the terrestrial volcanoes.

Differences in the shape, quantitative characteristics and volume of the studied volcanic edifices of Venus and Earth are probably related to the following: (1) different viscosity of lavas (lower-viscosity, higher-temperature lava on Venus); (2) different productivity of volcanism (the higher eruption rates on Venus); (3) different PT-conditions on the surface of the studied planets (the rate of cooling of lavas on Venus probably lower); (4) different thickness and penetrability of the lithosphere (perhaps, the thicker/rigid lithosphere of Venus requires larger volcanic sources for its penetration).

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