DIFFERENCES IN THE FORMATION MECHANISM OF RIFTS OF THE EARTH AND OF RIFTS IN THE VALLES MARINERIS SYSTEM OF MARS.

E.E. Milanovsky and A.M. Nikishin, Geological faculty, Moscow State University, 117234, Moscow, USSR.

The upper crust 8 to 15 km thick experienced brittle deformation in the result of its extension, whereas its lower part experienced viscous deformation (Artyushkov, 1981; Bott, 1981). The less the heat flow is the relatively deeper is the boundary between the brittle and ductile crust. During the rifting (fig.1) normal and listric faults are formed in the brittle crust, and its bedded zone subsides in the mechanically thinned lower ductile crust (Artyushkov, 1981). Subsequent extension of the crust causes widening of the rift, formation of the axial zone of high extension, up-break of the sialic crust within it and generation of the axial zone with the oceanic crust (Milanovsky, 1976). Consequently, the width and structure of continental rifts of the Earth depends on the degree of the crust extension.

Rifts of the Valles Marineris system at Mars have alternating width and depth. The net pattern of the depression bounded by faults (fig.2) reveal their origin as the result of dissection and vertical various-scale subsidence of blocks. The type of the depression structures and, therefore the mechanism of their formation, do not depend considerably on their width, depth and shape in plan. In all depressions, no axial zones of high extension have been traced.

Various parameters of the Earth’s and Mars’ crust and lithosphere can probably explain the difference in their rift structures. During the rifting the Mars’ crust and lithosphere in Tharsis region were considerably more thick than in the areas of the Earth’s continental rifts (Christensen, Bali, 1979; Toksoz, Hsui, 1978; Milanovsky, Nikishin, 1981). The brittle/ductile boundary in Mars’ crust presumably was located in its lower part because of less heat flow at Mars, contrast to that of the Earth.

The structural analysis of the rift system of the Valles Marineris revealed its formation under conditions of horizontal extension; it led to the plastic extension of the lower ductile crust and over-asthenosphere layer of the mantle and mechanical dissection of blocks in the above relatively thick crustal layer bounded by vertical faults and their subsidence in the zone of mechanically thinned viscous lithosphere (fig.1b). The shape and relative position of basins was controlled by the stress field. The vertical character of rift-controlling faults of Mars can be explained by their geometry in plan and by great thickness of the brittle crust.

References

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Fig. 1a. Formation of rift valleys on an Earth's continent (a) and in the Valles Marineris province of Mars (b) as a result of viscous extension and thinning of a strongly heated lower ductile crust and extension and subsidence of a brittle upper crust.

Fig. 2. Photogeology interpretation of structure of the some rift valleys of Valles Marineris region on Viking pictures.