A HYPOTHESIS FOR MARTIAN TOPOGRAPHY, TECTONICS AND VOLCANISM. Sz. Kósik[1], D. Karátson[1], A. Farkas[1], [1]Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Physical Geography (H-1117 Budapest, Pázmány Péter sétány 1/c, Hungary), E-mail: kosiksz@eotvos.elte.hu.

Introduction: Surface elevation differences on Mars, up to 30 km, are the biggest in the Solar System. The highest points can be found on the gigantic shield volcanoes of Tharsis and Elysium [1], whereas the lowest are related to meteor impacts (e.g. Hellas and Argyre basins). Apart from the occasional low surfaces, the area north of 45-50° at the northern hemisphere is located 8-10 km lower than the other parts of Mars's surface (Fig.1.) [2,3].

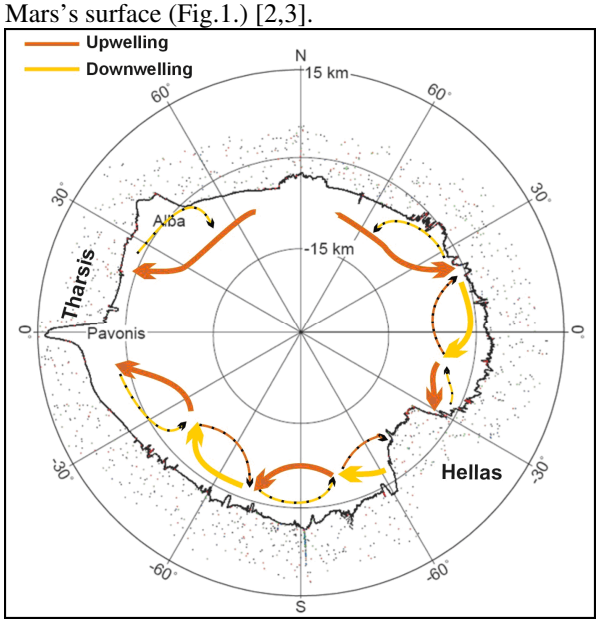

Fig.1. *Global profile of Mars with vertical exaggeration 1:100 [2]. Surface profile goes through longitude 50ºE on the left, crossing Tharsis province with Pavonis Mons and Alba Patera shield volcanoes, and through longitude 290ºE on the right, crossing the Hellas impact basin. The contrast in elevation and regional topographic roughness between the northern and southern hemisphere are apparent. The surface boundary (topographic escarpment) towards the northern low plains is at latitude ~50°. Figure also shows a supposed convectional system in the mantle. The dotted thinner and the thicker lines show differences in flux volume.*

How the Martian topographical dichotomy can be interpreted? In contrast to previous explanations, we think that the present surface dichotomy of Mars was not created by faulting related to compressional tectonics resulting from large-scale plate tectonic movements. We argue that by the time the present surface formed, the large-scale tectonic movements could be finished due to the last cooling stage of the planet's evolution, which hypothesis is opposed to the likelihood of subsequent faulting [4,5,6].

The last dynamic event of the Martian evolution was the large-volume volcanism related to magma upwelling similar to Earth's mantle plumes. When the gigantic shield volcanoes were erupting, the Martian crust could have been so rigid and/or the mantle upwelling so little-scale that the reduced plate tectonics were not favorable for generating ridges on the surface. This way the magma upwelling at first caused flexural uplift then surface volcanism (e.g. Tharsis plateau). Because above the plumes the Martian lithosphere was stationary, shield volcanoes of enormous size, exceptional in Solar System were formed (Fig.1.) This way the dimensions of the shield volcanoes, much larger than those in Hawaii [7], can be directly connected to the extinction of plate tectonics.

Subsequently, due to repositioning some portions of the Martian mantle and in part due to shrinking of the crust (resulting from cooling), a large area in the northern hemisphere was subsided along normal faults creating the present-day topographic dichotomy. The described process might also have contributed to creating the grabens of the southern uplands, explained previously by back-arc mechanism [8].

At Amazonian Period the surface of the subsided areas was partly covered by flood basalts, which in turn, as well as significant sedimentation, removed the tracks of previous impact craters [9]. Then as a result of the reduced erosion base level, large pediments formed at the boundaries of the Martian uplands and the low northern plains, covering the tectonic lineaments by up to several thousand meter-thick deposits.

Conclusion: We explain the topographic dichotomy, especially the northern lowlands of Martian surface by the formation of large shield volcanoes of the planet. Similar to Earth's geodynamics, the shield volcanoes of the Tharsis region could be releated to mantle upwellings. Nevertheless, considering the size (and the distribution) of these volcanoes major horizontal movements connected to plate tectonics are unlikely. Rather vertical movements (normal faulting) that created the northern lowlands could be generated by late-stage cooling and contraction. This way the topographical dichotomy could be explained by tectonic collapses of the northern hemisphere. However, until we do not have sufficient data for the deep structure of Mars, such a hypothesis as well all the other models cannot be verified.

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