Three-Dimensional Numerical Modeling of Tharsis Binucleus-Type Vortex Structure on Mars. Zuoxun Zeng[1, 2], Stuart Birnbaum[1], Hongjie Xie[1], Lilin Liu[2], Minqiang Zhu[1, 3], Weiran Yang[2] , [1]Department of Earth and Environmental Science, University of Texas at San Antonio, Texas, 78249, U.S.A., zuoxun_zeng@hotmail.com, [2]Faculty of Earth Sciences, China University of Geosciences, Wuhan, 430074, P.R.China, [3]Research Center of GIS and RS, East China Institute of Technology, Fuzhou, Jiangxi, 344000, P.R.China.

Introduction: The Tharsis region of Mars is intriguing for both its volcanic and tectonic activity. It is noticed that the distribution of fractures is radial to the Thrasis region [1]. Previous interpretations of this Tharsis radial-fracture pattern include strain associated with uplift [2] and radial dikes associated with volcanism [3]. The arcuate feature of the fractures was recently studied and interpreted as the product of regional and local tectonism [4] , while, more recently, the Tharsis arcuate radial fractures were interpreted as they belong to a vortex structure, the Tharsis binucleus-type vortex structure (TBVS) [5]. This type of structural pattern was first recognized and researched on Earth [6-7]. Here we mainly study the stress field forming the TBVS with 3-D finite element modeling.

Pattern: Centered in Pavonis Mons (247°E, 0°N) with a radius of ~3500 km, TBVS extends into both the southern and northern hemispheres of Mars. The pattern of the major extensional faults related to the TBVS is characterized by arcuate turbine blade-like radial faults, but the most developed among them constitute a sigmoidal fracture system trending northeast-southwest(Fig.1).

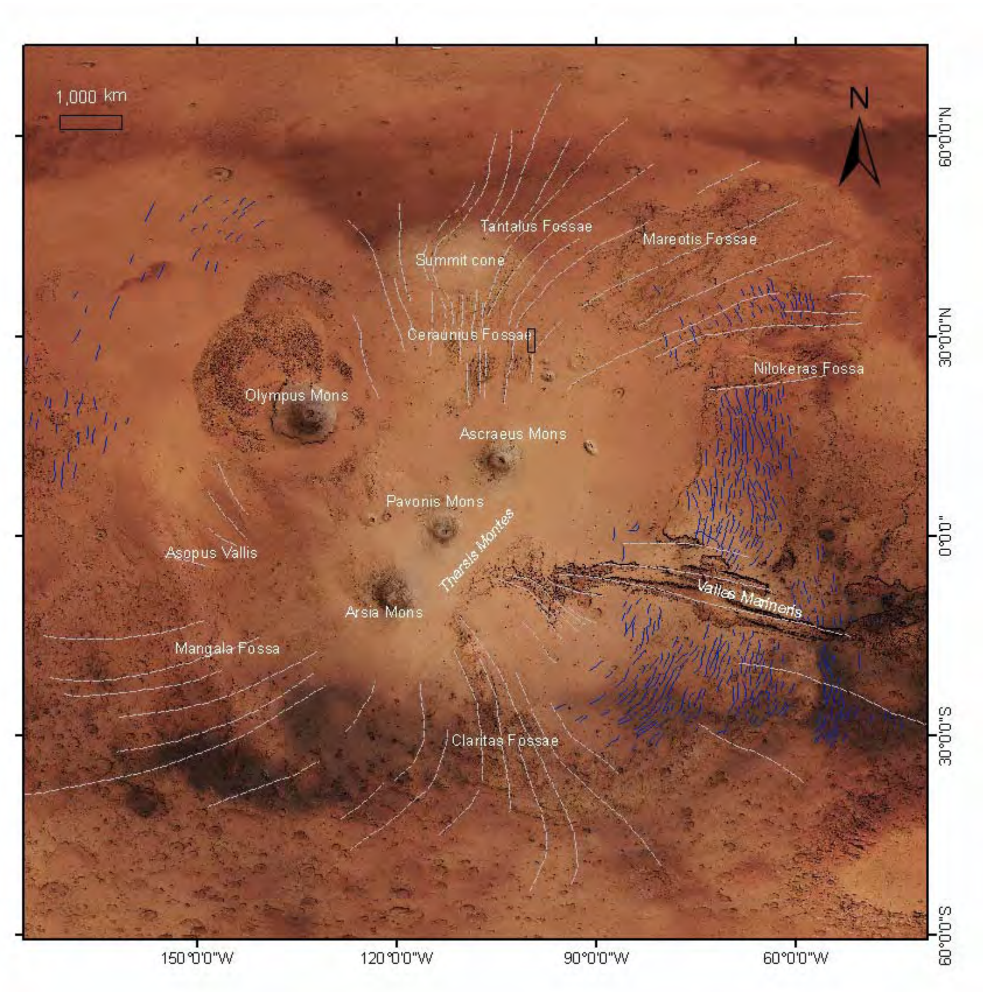

Fig.1 Distribution of grabens (white lines) and ridges (blue lines) in the TBVS [5]

Beneath the northeast Tharsis volcano chain a magma body with its long axis trending northeast is considered. In this case, the TBVS is similar to the Yegezikala binucleus-type vortex structure [6] with its nuclear column consisting of two cores linking together as one magma body. Associating with the extensional fractures is a set of compressive linear ridges. The ridges are perpendicular to the extensional fractures everywhere (Fig.1).

Modeling: An elastic shell model is accepted in the finite element modeling. The northeast-trending magma body is considered to be more competent than the country rocks. Associated with the magma body, the country rocks had a rotation of seven degrees around the center of the northeast volcano chain, or the center of the magma body(Fig.2). Fig.3 and Fig.4 shows the modeling result of the principal compressive stresses and principal tensile stresses, respectively. It is obvious that the directions of the principal compressive stresses are in total agreement with the extensional fractures in the TBVS. The directions of the principal tensile stresses correspond to the ridges in Fig.1.

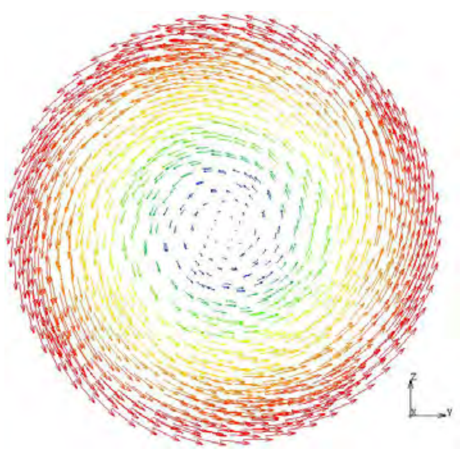

Fig. 2 Displacement vectors in 3-D model

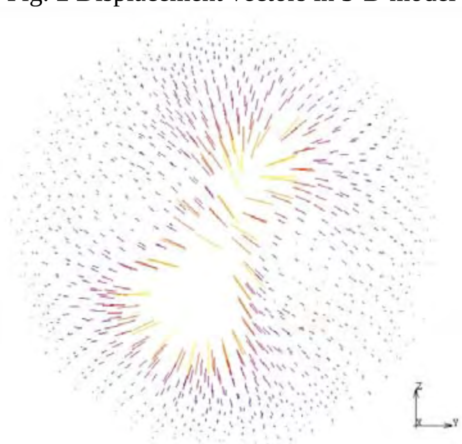

Fig.3 Principal compressive stresses in 3-D model

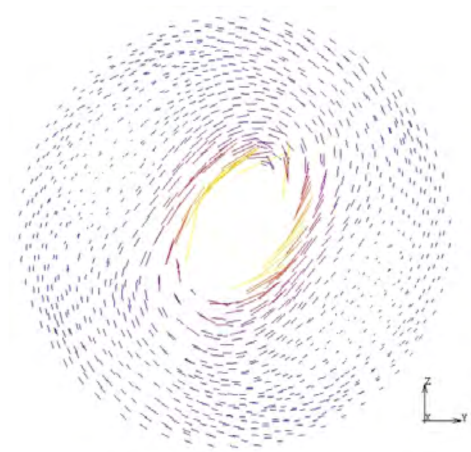

Fig.4 Principal tensile stresses in 3-D model

Discussion and conclusion: Combining the 3-D numerical modeling and the geometry of the arcuate radial fractures developed in the Tharsis region, we suggest that there is a magma body beneath the northeast-trending volcano chain along the Tharsis montes and that its country rocks experienced a small rotation around its center associated with the rotation of the magma body itself. We propose that the rotation resulted from a differential rotation between the northern and southern hemispheres of Mars and that the origin of the differential rotation is the product of differences in crustal thickness[8] and in composition between the two hemispheres.

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