Global Dynamical Significance of Zigzag Fractures in South Polar Ice Cap of Mars. Zuoxun Zeng[1,2,3], Zhenfei Zhang[1], Stuart J Birnbaum[2],Hongjie Xie[2], Weiran Yang[1,3] [1] China University of Geosciences,Wuhan, 430074, P.R.China, [2] University of Texas at San Antonio, Texas, 78249, USA, [3] Huazhong Tectonomechanical Research Center, Wuhan, 430074, P.R.China. zuoxun.zeng@gmail.com

Introduction: Fractures of different types have been interpreted in the polar ice caps of Mars [1-5]. Here we present regional Zigzag fractures and regional en echelon fractures in the south polar ice cap, we relate them to the spiral troughs in the south polar ice cap, and discuss their Martian dynamical significance.

Zigzag Fractures in the South Polar Ice Cap of Mars: The topographic map of the South Pole of the Mars reveals Zigzag fractures trending southeast developed in the area ranging between longitude 150ºE and 220ºE and latitude 70ºS and 82º S. It is easy to see that they are formed by tracing two sets of conjugate fractures trending South-East-South and East-South-East, respectively (Fig.1). Associated with the northeast trending Zigzag fractures is a set of northeast trending fractures developed near the south side of the latitude line of 75ºS. This is an en echelon fracture zone trending East-West. The combination of the Zigzag and en echelon fractures shows a left-lateral shear between the high and low latitudes in that region. We believe that the left-lateral shear between high and low latitudes implies an important Martian dynamical process.

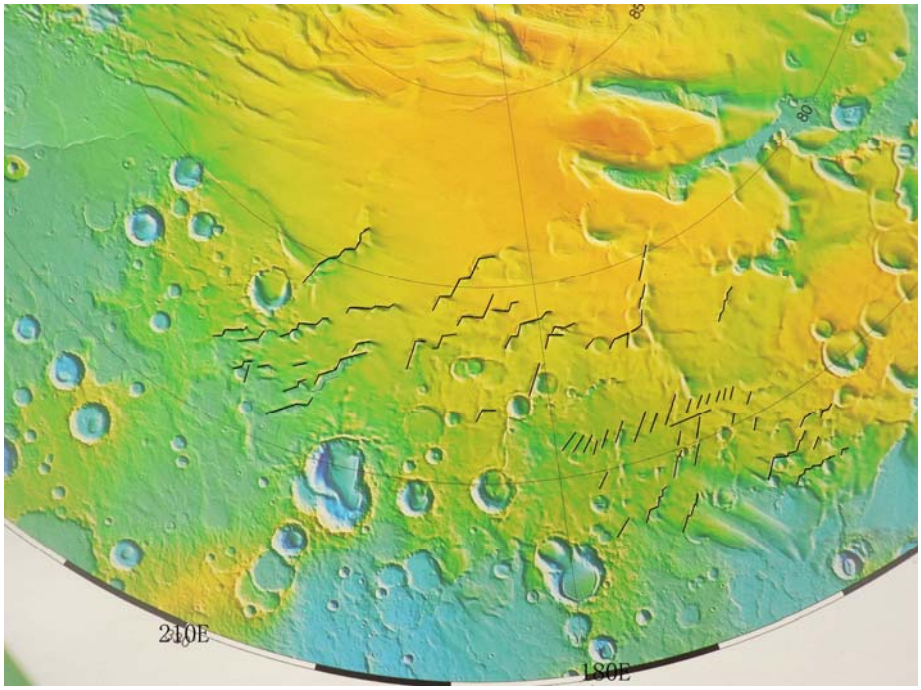

Fig.1. Zigzag fractures and en echelon fractures in the south polar ice cap of Mars (The base map is taken from a local part of The Topography of Mars by the MOLA science team, 2004[6])

Martian Dynamical Significance of the Combination of Zigzag and En Echelon Fractures: We know there is a centrifugal force of inertia (F in Fig.2) acting at any given point P on the spherical

surface of Mars resulting from its constant spinning about its axis:

$$F = \omega^2 \rho m \quad (1)$$

where ω is the angular velocity of the spinning, ρ is the distance from the point to the spinning axis measured perpendicular to the axis, and m is the mass within the volume at point P. We know from Eq.(1) that the centrifugal force of inertia is proportional to the distance from the point to the spinning axis. Given a mass, the centrifugal force of inertia at a low latitude is greater than that at a high latitude. Two extreme cases are zero centrifugal force of inertia at the pole and maximum centrifugal force of inertia at the equator. There is a latitudinal force of inertia in addition to the centrifugal force of inertia acting at a given point on the Martian surface while the spinning speed varies. According to the law of inertia, the magnitude of the force of inertia acting at a point of mass is equal to the product of the mass and the magnitude of the acceleration of the point with the direction of the inertia force being opposite to the direction of the acceleration. That can be expressed as Eq. (2):

$$f = m \frac{d\omega}{dt} \rho \quad (2)$$

(dω/dt) is positive and the latitudinal force of inertia is opposite to the spinning direction (see the f' in Fig. 2) when Mars spins up. The latitudinal force of inertia at low latitude is greater than that at high latitude attaining its maximum value at the equator and becoming zero at the pole. The difference between the latitudinal force of inertia at low and high latitudes of Mars can induce a left-lateral or right-lateral shear along the latitude direction. The left-lateral shear shown in Fig.1 indicates a westward motion of the low latitude area relative to the high latitude area. This implies that Mars has experienced an accelerating spinning since the formation of the south polar ice cap. This is the Martian dynamical process that formed the Zigzag fractures and the en echelon fractures in the south polar ice cap of Mars. It is consistent with the formation mechanism of the spiral troughs developed in the south polar ice cap of the Mars [2].

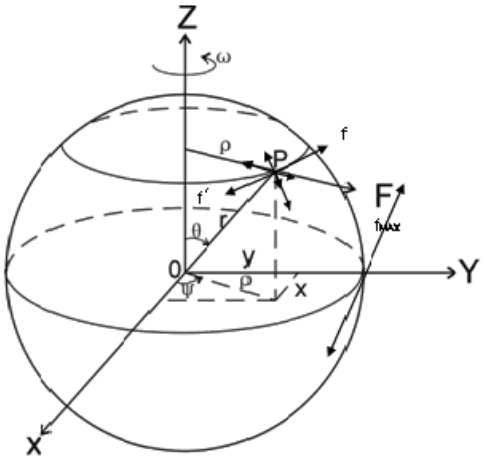

Fig.2 The centrifugal force of inertia F resulting from the constant spinning of Mars about its axis and the latitudinal force of inertia *f'* resulting from the accelerating spinning of Mars.

Conclusion: Zigzag fractures and en echelon fractures developed in the south polar ice cap of Mars are the result of left-lateral shear along the latitude direction. This implies an accelerating spinning of Mars about its axis after the formation of the south polar ice cap and provides a proof for the formation mechanism of the spiral trough in the south polar ice cap of Mars.

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References: [1] Milkovich S.M.et al. (2005) *36th LPSC*,#1080. [2] Zeng Z et al. (2007) *7th Int. Mars Con.,* #3368. [3] Putzig N. E. et al. (2007) *7th Int. Mars Con.,#3295.* [4] Zeng, Z., et al. (2008) *39th LPSC*,#2150. [5] Zeng, Z. (2008) *39th LPSC,* #2179. [6] MOLA science team, *The Topography of Mars, JPL* 400-942B, 2004.