Is the deformation around the MCT, 2D or 3D deformation?

Daigoro Hayashi

Simulation Tectonics Laboratory, Faculty of Science, University of the Ryukyus, Okinawa 903-0129 Japan, daigoro@sci.u-ryukyu.ac.jp

The channel flow model (Beaumont et al.,2001, 2004)and its early model, wedge extrusion model (Grujic et al.,2002; Jessup et al., 2006) are attractive models to explain the Himalayan and Tibetan enigma. The kinematic vorticity number Wk analysis is one of the most important method to prove these models from geological side, because from Wk we know the ratio between pure shear and simple shear. According to Jessup et al. (2006) they measured the low Wk in the MCTZ in southern area of Everest that should show high Wk according to the channel flow model. The discrepancy may be resolved if we accept the logics emphasized by Li, C. and Jiang,D. (2011) in which recent methods measuring Wk are only valid in 2D but invalid for 3D deformation. But if 2D deformation occur around natural metamorphic zones, e.g. MCTZ or STDS, the recent methods measuring Wk can work. Unfortunately we do not have the 3D strain analysis method using rigid particles, but we have the other 3D method using passive marker (Hayashi, 2001, 2008). Hayashi (2008) showed that the deformation was 3D in the HHC, MCTZ and LHC around the southern area of Annapurna in Fig.3, therefore we should develop fast a new method to measure Wk in the genuine 3D deformation.

3D strain analysis method using passive marker is briefly explained hereafter. Quartz grain is used as a passive strain marker which is assumed to deform from its initial ellipse shape to the final ellipse.

2D strain analysis

The fabric method (Wheeler, 1986) is used for 2D strain analysis where calculation is performed by computer, since the method does not need the graphical and other manual operations but needs algebraic treatment only. Figure 1 explains the fabric method. Marker ellipses are deformed by “deformation tensor D”. The deformed marker ellipses are averaged into a fabric ellipse. On the other hand, we can calculate a strain ellipse from the deformation tensor D. The fabric method maintains that the fabric ellipse is identical to the strain ellipse under the next four conditions. (1) Initial shape of marker is ellipse.(2) There is no initial foliation within markers.(3) There is no competency contrast between markers and matrix.(4) Markers are deformed in homogeneous finite strain. (Wheeler, 1986).

3D strain analysis

Least square method (Hayashi, 1994,2001) is used for 3D strain analysis. After the 2D strain analysis, we have already obtained the direction of long axis and the axial ratio of the strain ellipses on the planes A, B and C as shown in Fig.2. The following procedure is necessary to obtain the 3D strain. (1) Calculate the relative axial length of the strain ellipses by GS method (refer Hayashi, 1994,2001).(2) Calculate the shape tensor of the strain ellipsoid that is constructed from the strain ellipses by the least square strain technique.

(3) Calculate the axial lengths X, Y and Z using the eigen values of the shape tensor of the strain ellipsoid. Supposing that λ_1, λ_2 and λ_3 are the eigen values of the shape tensor and that $\lambda_1 \le \lambda_2 \le \lambda_3$,we have the axial lengths of the strain ellipsoid as

$$X = \sqrt{\frac{1}{\lambda_1}}, \qquad Y = \sqrt{\frac{1}{\lambda_2}}, \qquad Z = \sqrt{\frac{1}{\lambda_3}}$$,where X>Y>Z.

(6) Calculate the direction of X, Y and Z of the strain ellipsoid using the eigen vectors of the shape tensor. The direction of X, Y and Z equals that of the eigen vectors which correspond with λ_1, λ_2 and λ_3, respectively.

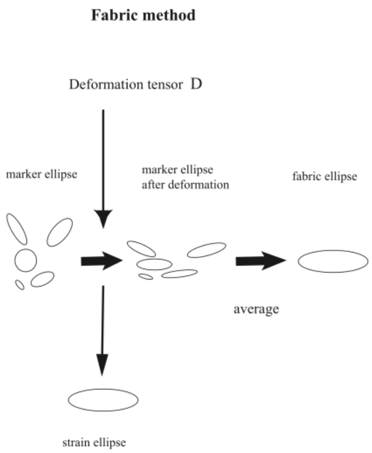

Fig.1

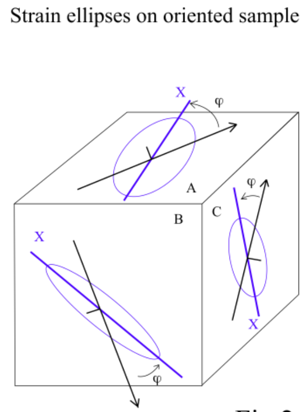

Fig.2

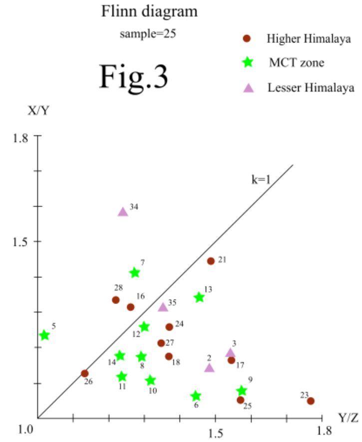

Fig.3

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