GY403 Strain Problem Set

Given:

The following equations derived from the finite strain ellipse, and the below Figure 1 diagram:

$$\lambda' = \frac{\lambda'_X + \lambda'_Z}{2} - \frac{\lambda'_Z - \lambda'_X}{2} Cos2\theta_d \qquad \textbf{(1)}$$

$$\frac{\gamma}{\lambda} = \frac{\lambda'_Z - \lambda'_X}{2} Sin2\theta_d \qquad \textbf{(2)}$$

$$\tan\theta_d = \tan\theta \frac{S_Z}{S_X} \qquad \textbf{(3)}$$

Where θ_d is the angle that a deformed line makes with the major axis (X) of the finite strain ellipse, and θ is the angle that the line made with the X direction before deformation. Subscripts (X) and (Z) refer to parameters measured parallel to the (X) major axis of the strain ellipse in Figure 1, (Z) to the minor axis. The below equations will prove helpful in solving the problem:

$$\lambda' = \frac{1}{\lambda} = \frac{1}{S^2}$$

$$S = stretch = \frac{l_F}{l_O}$$

$$\lambda = quadratic\ elongation = S^2$$

$$\gamma = shear\ strain = \tan(\psi)$$

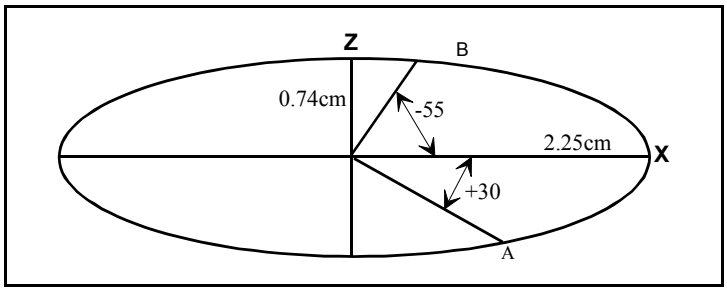

Figure 1. XZ plane of strain ellipsoid.

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The measured lengths of X and Z in Figure 1 refer to the elliptical diameter in each respective direction. Assume that the undeformed state consisted of a sphere with diameter = 1.0cm.

Calculate:

For the lines (A) and (B) that are elliptical diameters to the strain ellipse in Figure 1, with θ_d angles of +30° and -55° respectively, calculate the following values:

Calculate:
(1) λ (quadratic elongation)
(2) S (stretch)
(3) γ (shear strain)
(4) ψ (angular shear)
(5) α (angle of internal rotation)