Plastic (Von Mises) Creep

$\sigma_d = C$ (constant)

where σ_d is differential stress.

Viscous (Newtonian) flow

Strain rate $\dot{e} \propto \sigma_d$

where σ_d is differential stress. Alternatively:

$\sigma_d = \eta \dot{e}$

where η = viscosity.

Specific equation for diffusional creep

$\dot{e} = A\sigma_d \exp\left(-E^*/RT\right) d^{-r}$

where d is the grain size and r is 2 for grain-boundary diffusion and 3 for volume diffusion

Power Law Creep

$\dot{e} \propto \sigma_d{}^n$

where k and n are constants

or more specifically

$\dot{e} = A\sigma_d^n \exp\left(-E^*/RT\right)$

where A and n are constants for the material, E* is the activation energy, R is the gas constant and T is the absolute temperature.

Exponential Creep

$\dot{e} \propto \exp(\sigma_d)$

or more specifically:

$\dot{e} = A\exp(\sigma_d)\exp\left(-E^*/RT\right)$

where A is a constant for the material, E* is the activation energy, R is the gas constant and T is the absolute temperature

Progressive strain and flow

Longitudinal strain rate $\dot{e} = \frac{de}{dt}$

Shear strain rate $\dot{\gamma} = \frac{d\gamma}{dt}$

Velocity gradient matrix $\mathbf{L} = \begin{pmatrix} L_{11} & L_{12} & L_{13} \\ L_{21} & L_{22} & L_{23} \\ L_{31} & L_{32} & L_{33} \end{pmatrix}$

or (in 2 dimensions) $\mathbf{L} = \begin{pmatrix} L_{11} & L_{13} \\ L_{31} & L_{33} \end{pmatrix}$

Velocity at any point x is given by **v = Lx**

or $\begin{pmatrix} v_1 \\ v_3 \end{pmatrix} = \begin{pmatrix} L_{11} & L_{13} \\ L_{31} & L_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ x_3 \end{pmatrix}$

Stretching and rotation components of L

$\mathbf{L} = \mathbf{S} + \mathbf{W} = \begin{pmatrix} \dot{e}_{11} & \frac{1}{2}\dot{\gamma} \\ \frac{1}{2}\dot{\gamma} & \dot{e}_{33} \end{pmatrix} + \begin{pmatrix} 0 & \frac{1}{2}\dot{\gamma} \\ -\frac{1}{2}\dot{\gamma} & 0 \end{pmatrix}$

Kinematic vorticity number:

W_k = rotation rate/distortion rate = cos(α)

where α is the angle between the eigenvectors of **L**

Simple shear zones

If γ=shear strain, orientation θ of finite extension axis s_1 to shear-zone boundary is given by: $\tan(2\theta) = 2/\gamma$