Stress-strain relationships

Elastic strain

Linear stress $\sigma_n = E.e$
Poisson's ratio $\nu = - e_1/e_3$
shear stress $\sigma_s = G.\gamma$
mean stress $\sigma_m = -K\Delta$
where E = Young's modulus of elasticity;
G = shear modulus of elasticity;
K = bulk modulus of elasticity;
e_1, e_3 are principal extensions of sample under uniaxial compression.

Relationships between the elastic moduli

$$G = \frac{E}{2(1+\nu)} \qquad K = \frac{E}{3(1-2\nu)}$$

Brittle Failure

Coulomb fracture criterion
$\sigma_s = C + \sigma_n \tan\phi$
where C is a constant and ϕ is the angle of internal friction.

"Byerlee's law" for movement on existing fractures

$\sigma_s = 0.85\sigma_n$ ($\sigma_n < 200$ MPa)
$\sigma_s = 50 + 0.60\sigma_n$ ($\sigma_n > 200$ MPa)

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

Plastic (Von Mises) Creep

$\sigma_d = C$ (constant)

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

$\dot{e} \propto \exp(\sigma_d)$ where k and n are constants
or more specifically:
$\dot{e} = A\exp\left(\sigma_d\right)\exp\left(-E^*/RT\right)$
where A is a constant for the material, E* is the activation energy, R is the gas constant and T is the absolute temperature

Strain in 3 dimensions

Principal strains are designated by subscripts 1, 2 and 3, e.g. principal elongations are $e_1 > e_2 > e_3$
Principal stretches are $S_1=X$, $S_2=Y$, $S_3=Z$
Dilation $1+\Delta = S_1S_2S_3$
Condition for plane strain: $S_2=1$; $S_1S_3=1$

Strain ratios for Flinn plot

$a = S_1/S_2$
$b = S_2/S_3$
Shape parameter $k = a/b$