I. Continuum Models of Material Behavior

A. Continua: assumption that rocks behave as cohesive mechanical units, averaging out effects of local anisotropies and polycrystalline nature

B. Rheological Models for Rock

1. Elastic Behavior

a. linear elastic behavior: material deforms by an amount proportional to the applied stress

(1) when stress is released, material strain recovers to original undeformed state

(2) Young's Relations

(a) Stress = E(strain)

b. Similar to Hooke's law for a spring (ideal elastic)

(1) Force = k(spring displacement)

c. Stress-strain diagram

(1) normal stress on y axis
(2) lengtening or shortening strain on x axis

(3) true elastic solid: linear relationship

2. Viscous Behavior

a. example fluid behavior

(1) stress applied to fluid: fluid deformation (motion)

(a) remove stress, fluid stops, but does not recover to initial state

b. Viscous behavior: nonrecoverable strain

(1) Newtonian fluid

(a) linear relation between stress and strain rate

(b) > stress, > rate of strain (dx/dt)

(c) Newtonian stress-strain diagram

i) stress = y-axis
ii) strain rate = x-axis

iii) as stress --- 0, strain rate ----- 0, but strain does not recover (permanent deformation)

(2) Bingham fluid

(a) exponential relation between stress and strain rate

(b) internal shear strength of fluid exists

i) at low stress, strain rate is low
ii) at high stress, strain rate > exponentially

(3) Rocks as Newtonian Fluids

(a) under higher temps. and press., rocks may behave as viscous materials

3. Plastic Behavior

a. Plastic materials

(1) at low stress, materials undergo elastic deformation until critical yield stress is exceeded (yield strength)

(2) yield stress: critical stress (strength) of material, beyond which material undergoes permanent deformation

(a) stress < yield strength = elastic deformation relations (linear, recoverable strain)

(b) stress > yield strength = plastic deformation relations (non-linear, non-recoverable strain)

i) material flow, ductile deformation

4. Compound Behavior (Other continuum models)

a. Visco-elastic (Maxwell solid)
b. Elastic-elastic (Prandtl Material)
c. Visco-plastic (Bingham Material)
d. Firmo-viscous

II. Experimental Studies

A. Overview and Philosophy of Rheologic Experimentation

1. Procedures

a. stress-strain diagram generation
b. variables: temperature, pressure, material composition

2. Mathematical Analysis