

Engineering Geology

Lecture-3

Physical/ Index Properties of the Rocks

When rocks break in response to stress, the resulting break is called a **fracture**. If rocks on one side of the break shift relative to rocks on the other side, then the fracture is a **fault**. If there is no movement of one side relative to the other, and if there are many other fractures with the same orientation, then the fractures are called **joints**.

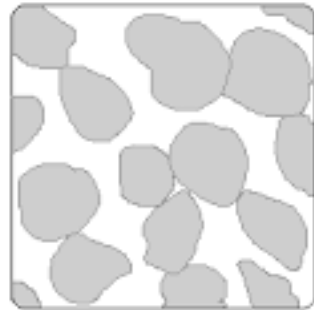


Cleavage - The tendency of a mineral to break along flat planar surfaces as determined by the structure of its crystal lattice. These two-dimensional surfaces are known as **cleavage planes** and are caused by the alignment of weaker bonds between atoms in the crystal lattice.

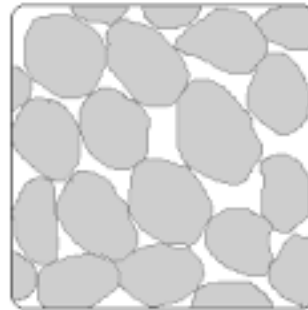


<https://openpress.usask.ca/physicalgeology/chapter/13-3-fractures-faults-and-joints-2/#:~:text=Most%20joints%20form%20when%20the,a%20body%20of%20rock%20expanding.>

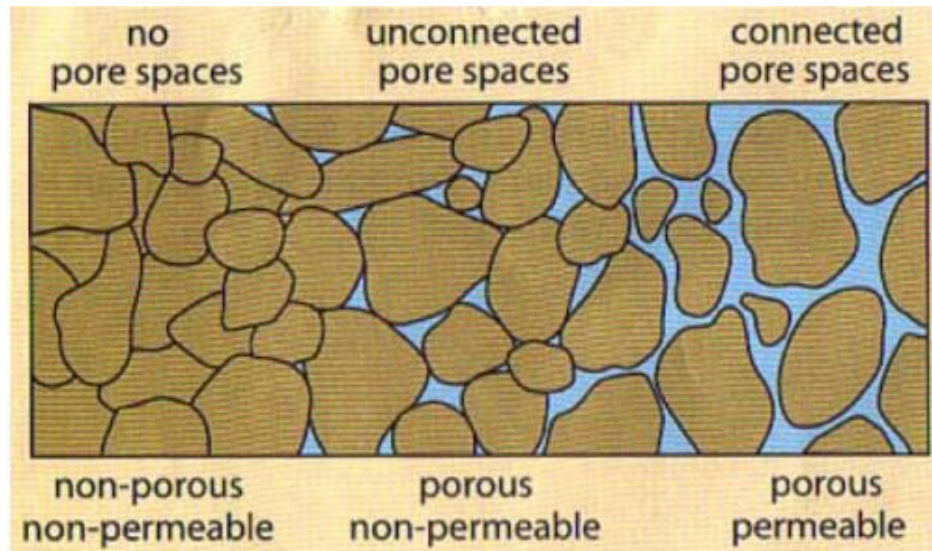
POROSITY & PERMEABILITY



a) High porosity



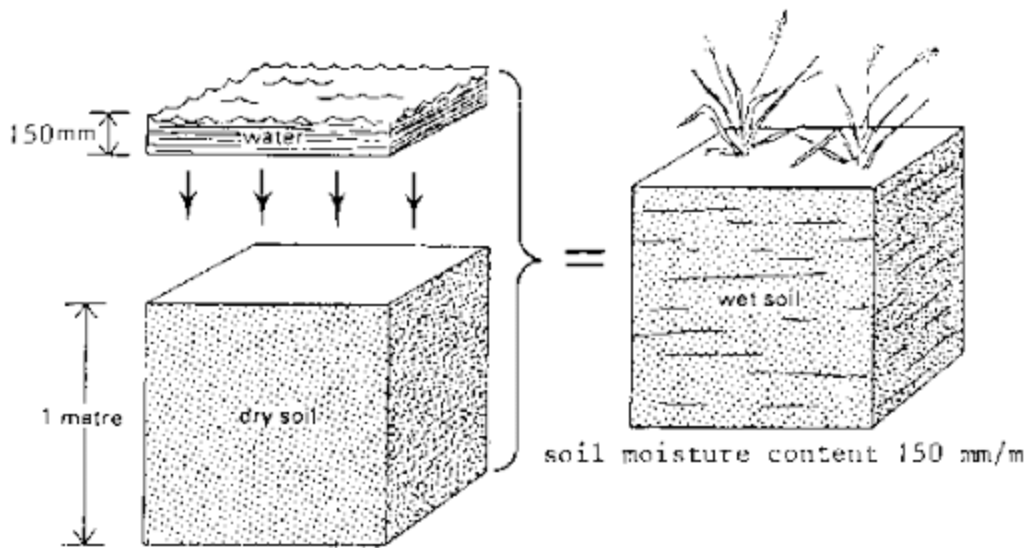
b) Low porosity



Density



Moisture Content



$$m = \frac{W_w}{W_s}$$

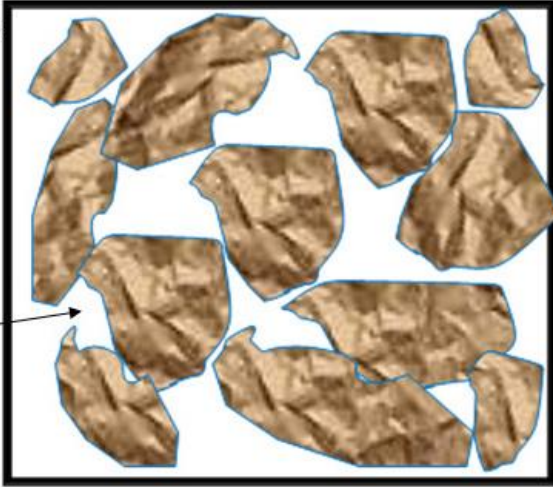
m = the moisture content.

W_w = the weight of water,

W_s = the weight of solids.

Degree of Saturation

Total volume;
 V



Volume of
Voids;
 V_v

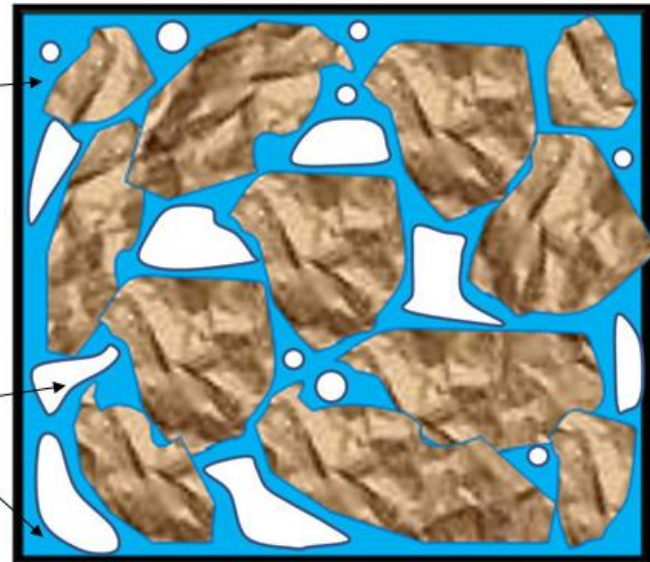
$$S = \frac{V_w}{V_v}$$

S = the degree of saturation,
 V_w = the volume of water,
 V_v = the volume of void.

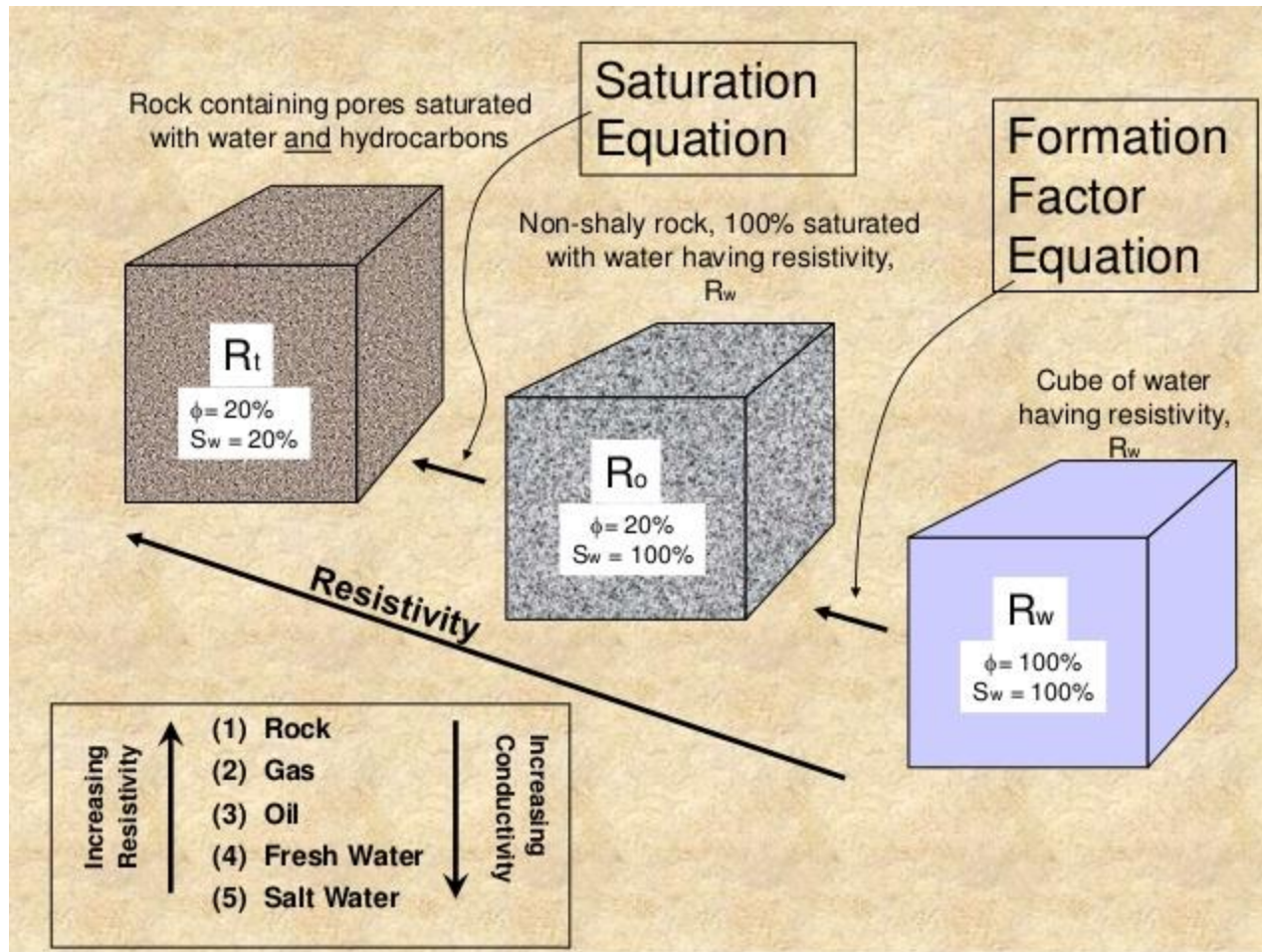
Volume of
Water;
 V_w



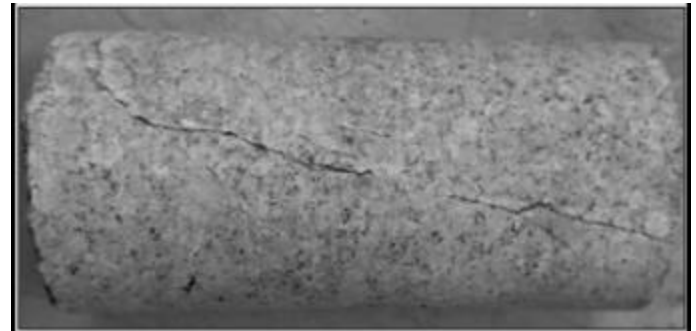
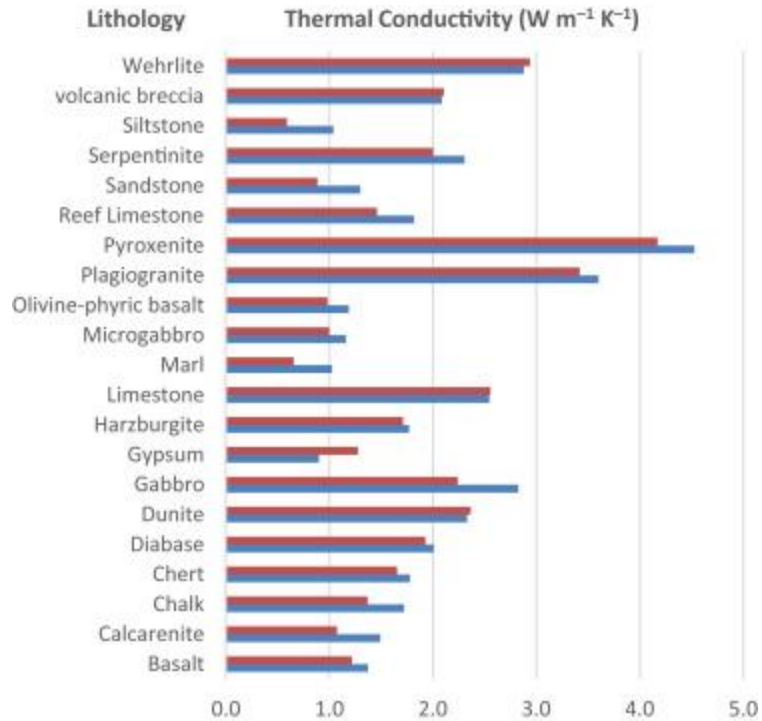
Volume of
Voids;
 V_v



Electrical Properties



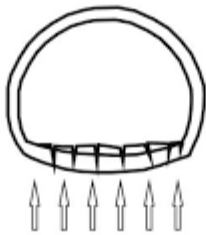
Thermal Properties



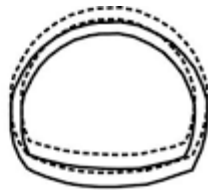
Swelling



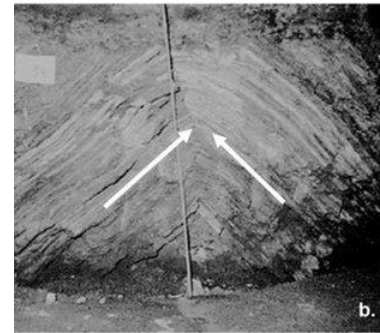
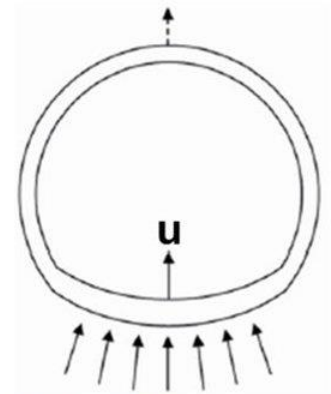
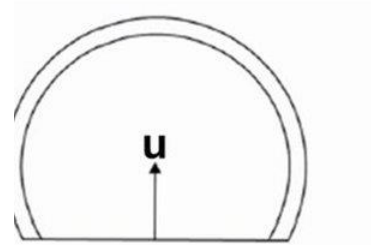
Heave of invert



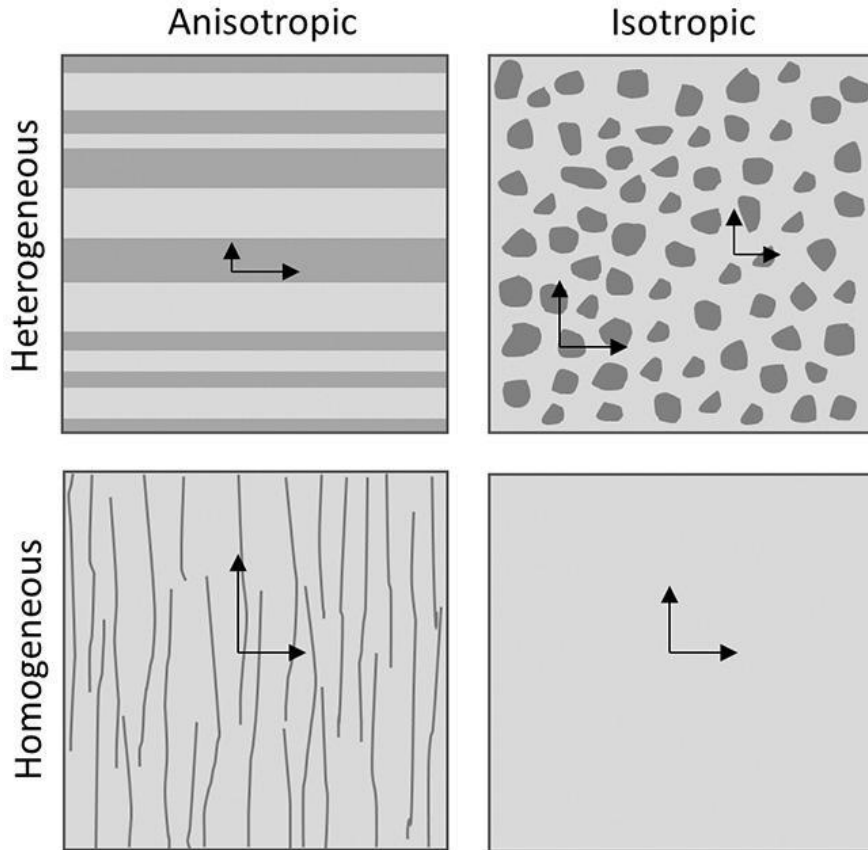
Swelling pressure



Heave of entire tunnel



Anisotropy



Durability

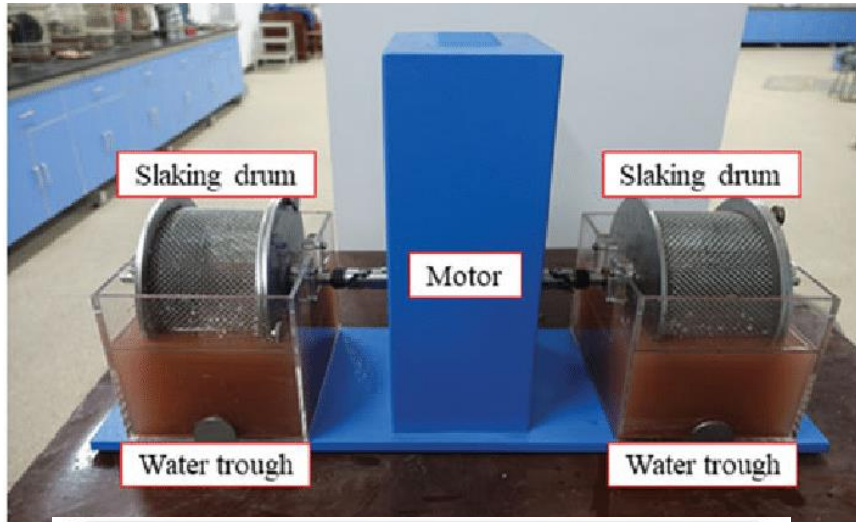


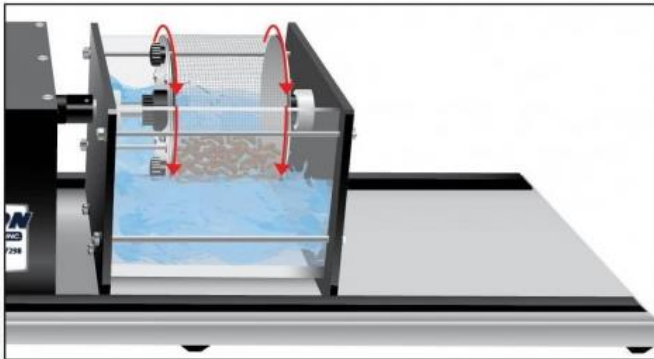
Table 1. Visual description of the rock samples retained in the test drum after the second cycle (after Franklin and Chandra, 1972).

Type	Description
I	Pieces remain virtually unchanged
II	Consist of large and small pieces
III	Exclusively small fragments

Table 2. Slake durability index classification (after Franklin and Chandra, 1972).

ID ₂ (%)	Durability classification
0 - 25	Very Low
26 - 50	Low
51 - 75	Medium
76 - 90	High
91 - 95	Very High
96 - 100	Extremely High

SLAKE DURABILITY INDEX

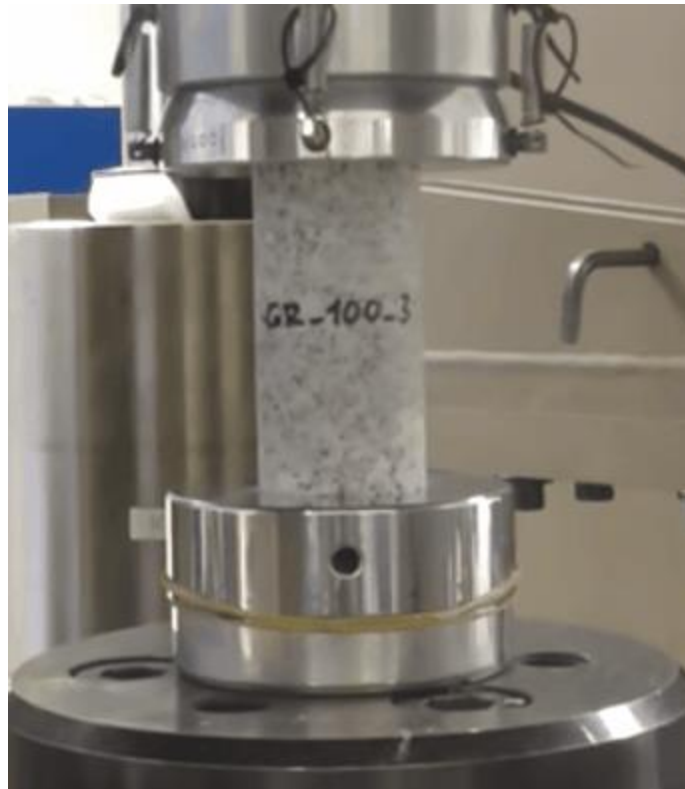


A pre-weighed sample is placed in a partially submerged wire mesh drum, tumbled for 10 minutes, then oven dried and weighed. Retained mass is calculated and recorded for each of two cycles.

Mechanical/Engineering Properties

Strength

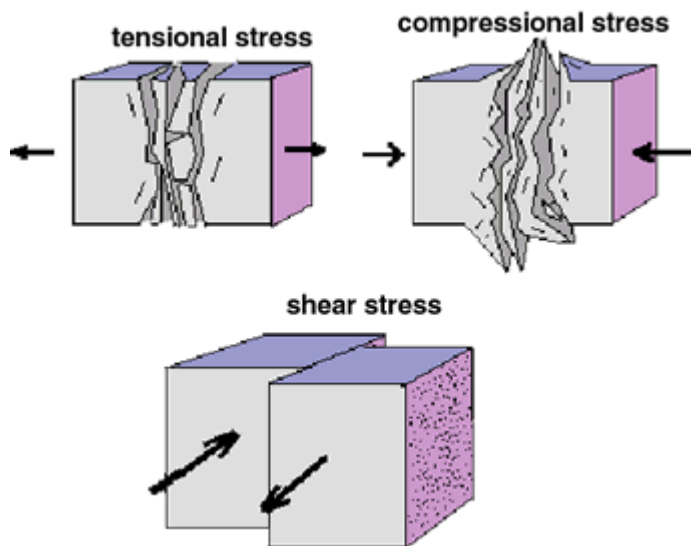
- Unconfined Compressive Strength
- Triaxial Compressive Strength
- Shear Strength Test
- Point Load Strength



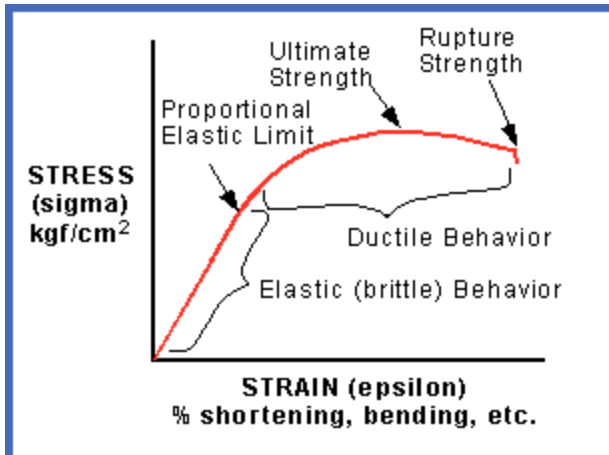
Strength

- ◆ Shear strength: a vital geomechanics measure, used for design
- ◆ Shearing is associated with:
 - Borehole instabilities, breakouts, failure
 - Reservoir shear and induced seismicity
 - Casing shear and well collapse
 - Reactivation of old faults, creation of new ones
 - Hydraulic fracture in soft, weak reservoirs
 - Loss of cohesion and sand production
 - Bit penetration, particularly PCD bits

σ_3

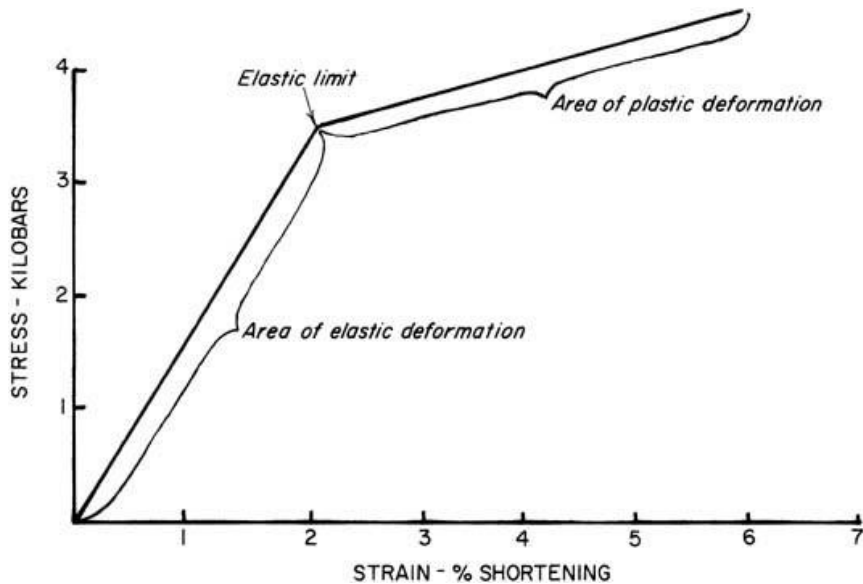


Elasticity

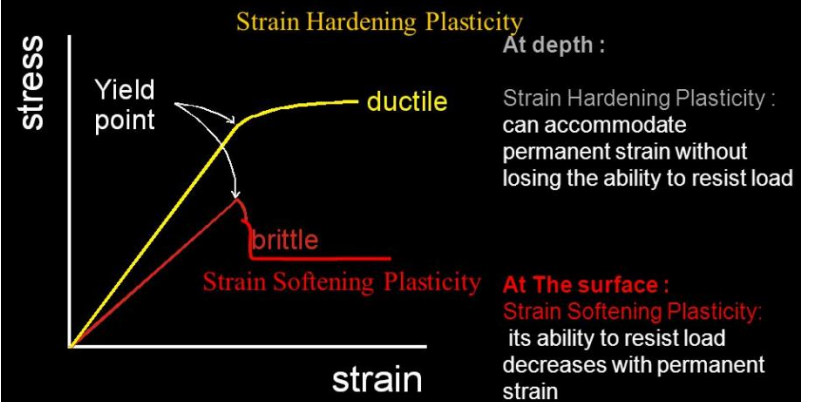


- Ability of materials to resist and recover from deformations produced by forces.
- Applied stress leads to a strain, which is **reversible** when the stress is removed.
- The relationship between stress and strain is linear; only when changes in the forces are sufficiently small.
- Most rock mechanics applications are considered linear.
 - Linear elasticity is simple
 - Parameters needed can be estimated from log data & lab tests.
- Most sedimentary rocks exhibit non-linear behaviour, plasticity, and even time-dependent deformation (creep).

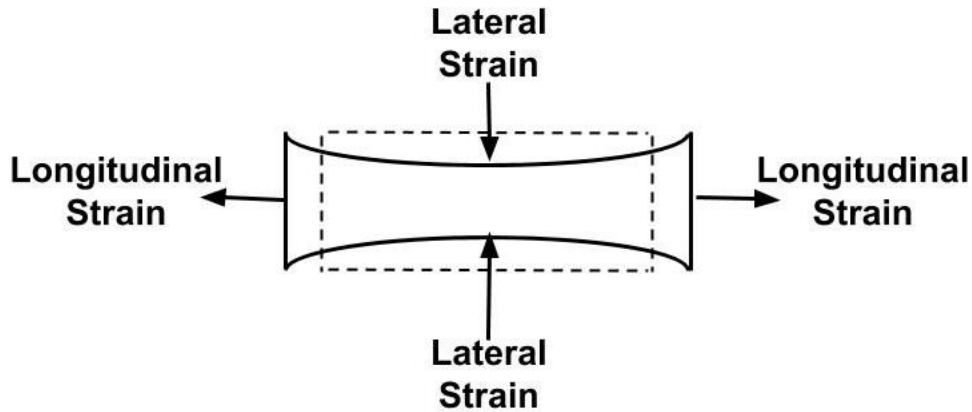
Plasticity



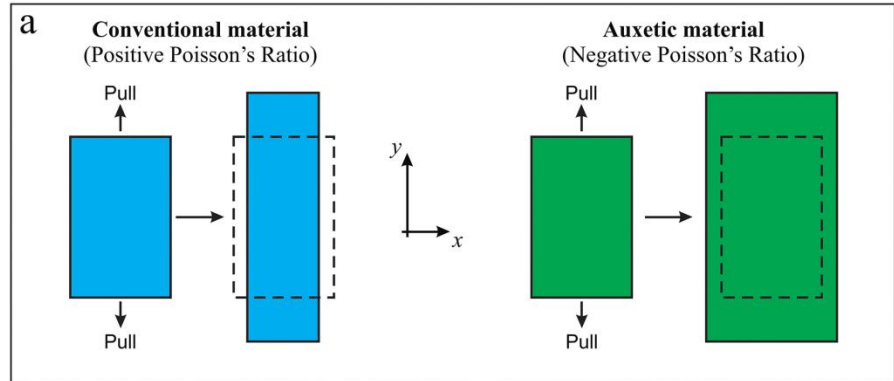
Two distinct types of plasticity



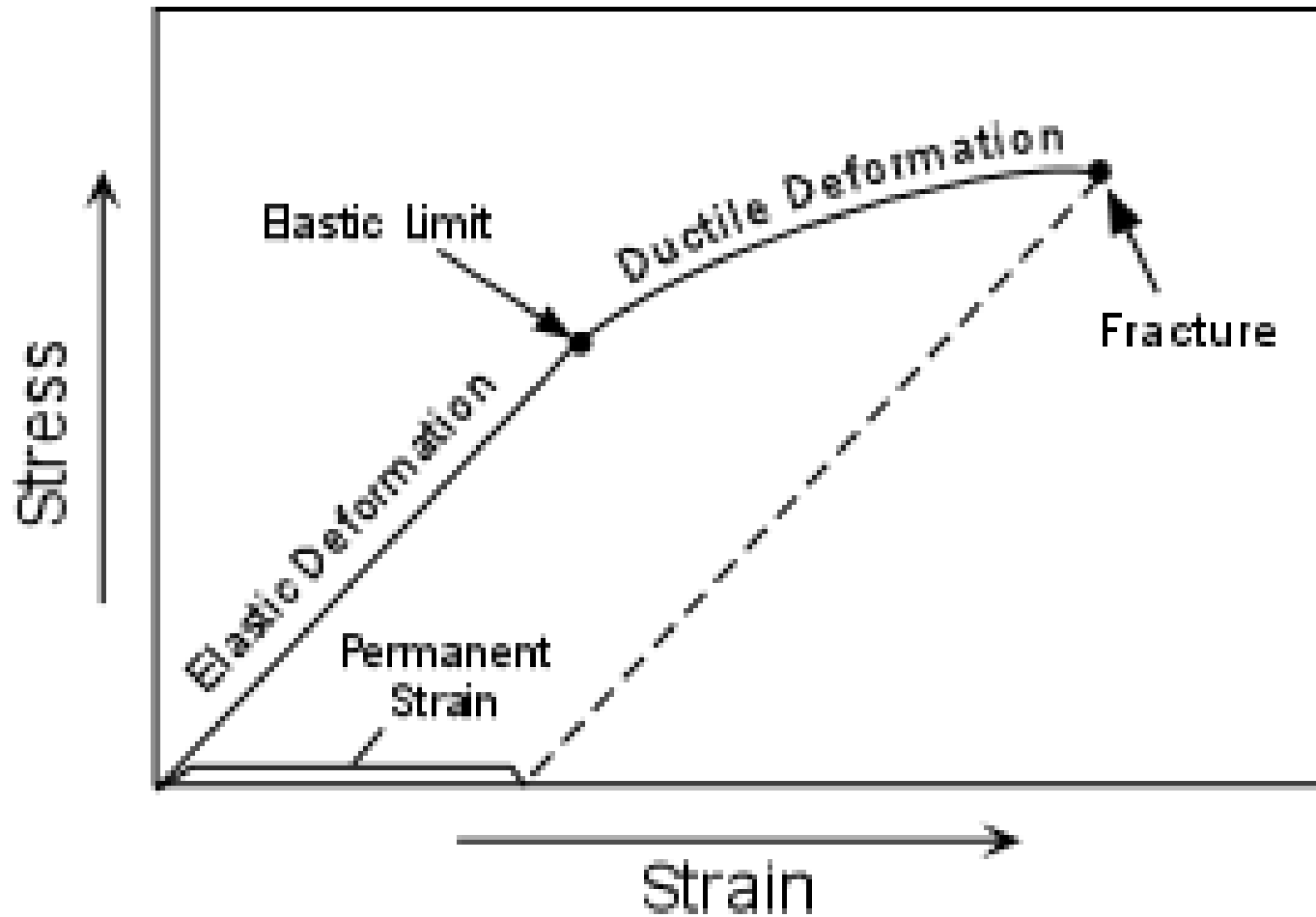
Poisson's Ratio



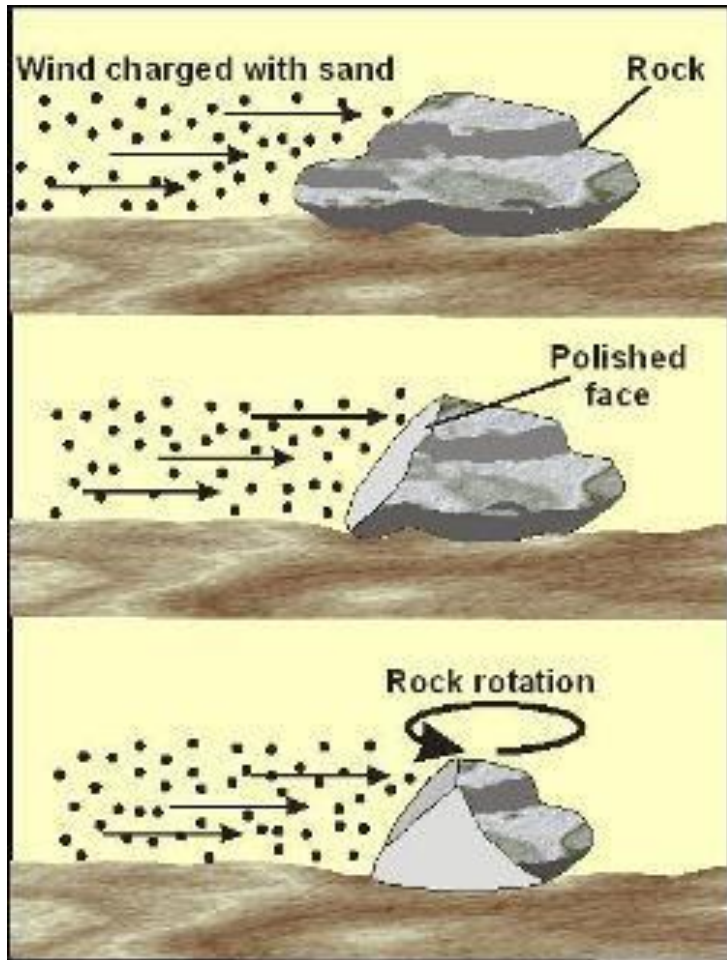
$$\text{Poisson's Ratio} = \frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$



Deformability



Hardness



Resistance to abrasion

Abrasion is the physical process of rubbing, scouring, or scraping whereby particles of **rock** (usually microscopic) are eroded away by friction.