



Elastic Properties

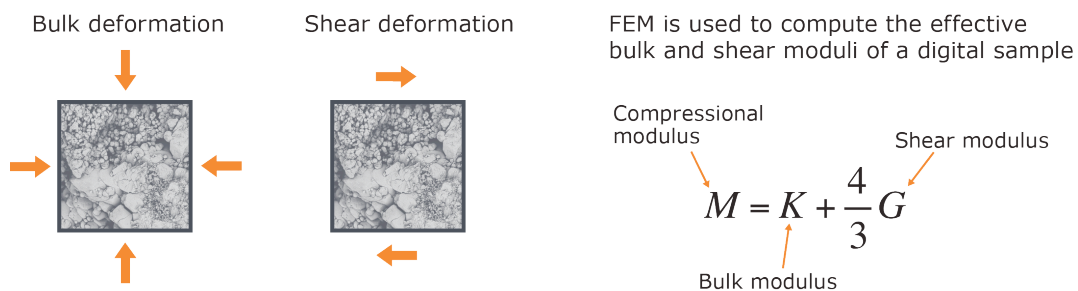
An elastic property is the measurement of the tendency of a rock to deform non-permanently in various directions when stress is applied.

Ingrain determines elastic moduli by simulating a static deformation experiment on a 3D digital rock sample.

The application of stresses to the faces of the sample generates strains in the rock frame that are computed locally using the finite element method (FEM). The resulting effective deformations of the sample are related to the stresses applied at the boundaries to calculate the effective elastic moduli. This application assumes linear elasticity laws are valid within the sample. Therefore, the elastic moduli thus obtained can be converted into the elastic-wave velocities.

Computational setup for elastic moduli determination

Various loading configurations are applied to the same digital sample to obtain the effective elastic moduli (e.g., the bulk and shear).



Velocities are calculated from the elastic moduli and bulk density

P-wave velocity

$$V_p = \sqrt{\frac{M}{\rho}}$$

S-wave velocity

$$V_s = \sqrt{\frac{G}{\rho}}$$

Bulk density

Poisson's ratio

$$\nu = \frac{1}{2} \frac{M/G - 2}{M/G - 1}$$

Young's ratio

$$E = 2G(1 + \nu)$$