Continuum Concept Applied to Rock Physics

Continuum Mechanics

A continuum is an idealized material whose physical properties—strength, density, stiffness, etc.—vary continuously and smoothly from point to point.

Discontinuities or jumps in properties indicate a breakdown in the concept of a continuum and therefore must be treated as a boundary of the continuum.

These definitions are idealized and we must take special care to apply continuum mechanics to real materials, because real materials are always heterogeneous at one or more scales.
Example: the density of a continuum

We can estimate the density at a point P, by drawing some small, but finite volume containing P and determining the total mass within that volume. If the material is a continuum, shrinking the volume should cause the ratio to go to a well-defined limit.

\[ \rho_P = \lim_{v \to 0} \frac{M_v}{V} \]
How appropriate is a continuum description for real materials?

We must recognize that at too small a scale the density defined above will actually be discontinuous. We have learned from experience that the concept of mass is useful as long as we choose scales much larger than an atomic dimension.

For other problems we will sometimes choose scales much larger than a mineral grain or individual pore, in order to talk about the average density of a rock.
Real earth materials are characterized by heterogeneity. We must be constantly aware of the nature of the heterogeneity and its scale.