$$\frac{\partial(\phi\rho)}{\partial t} + \nabla\cdot(\rho\phi\vec{v}) = 0$$

Darcy's law (1856)

$$\vec{Q} = -\frac{\bar{\bar{K}}}{\mu}\left(\nabla p - \rho\vec{g}\right)$$

volume per unit time flowing thru a cross section

$$\vec{v} = \frac{\vec{Q}}{\phi} = -\frac{\bar{\bar{K}}}{\phi\mu}\left(\nabla p - \rho\vec{g}\right)$$

$$\bar{\bar{K}} = \begin{bmatrix} k_{11} & k_{12} & k_{13} \\ k_{12} & k_{22} & k_{23} \\ k_{13} & k_{23} & k_{33} \end{bmatrix} = \begin{bmatrix} k_{xx} & k_{xy} & k_{xz} \\ k_{xy} & k_{yy} & k_{yz} \\ k_{xz} & k_{yz} & k_{zz} \end{bmatrix}$$

if isotropic

$$\bar{\bar{K}} = k(\vec{x})\,\delta_{ij} = \begin{bmatrix} k(x) & 0 & 0 & \\ 0 & 0 & k(x) & 0 \\ 0 & 0 & 0 & k(x) \end{bmatrix}$$

if homogeneous

$$k(\vec{x}) = k$$