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1 Osmotic filtration in deformable rocks

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The new model of osmotic filtration in deformable rocks is proposed. The model is designed for coupled description of rheological and mass transport properties of swelling rocks. Model is founded on the classical methods of consolidation theory and chemical osmosis theory. The main improvement is concluded in using of the right rheological equation in Greenberg model. Our model contains from:

1. The mass balance equation:

$$\partial(m\rho_w)/\partial t + \text{div}(m\rho_w\vec{j}_w) = 0. \tag{1}$$

Here m – porosity, ρ_w – water density, $m\vec{j}_w = -m\sum_i \alpha_{wi}\nabla\mu_i = -k_w\nabla p - k_c\nabla c$ – summarizing thermodynamic's water flux, μ_i – correspondent chemical potential, α_{wi} – correspondent Onsager's coefficients, c – concentration, p – pressure.

1. Mechanical equilibrium equation:

$$\sigma^e + p\mathrm{I} = \mathrm{W}. \tag{2}$$

Hereσ^e – effective elastic stress tensor, I – unite tensor, W – total load.

1. Rheological correlations:

$$\sigma^e = (K - 2G/3)\varepsilon^e \mathrm{I} + 2G\varepsilon^e \tag{3}$$

Here K, G – elastic coefficients of porous matrix, ε^e – medium strain tensor.

1. Mass transport equation:

$$\partial(mc)/\partial t + \mathrm{div}(mc\vec{j}_c) = 0. \tag{4}$$

Here $mc\vec{j}_c = -k_w c \nabla p - D_c \nabla c$ – total species flux, D_c – dispersion coefficient. After solution of equations we investigated the features of our model, which are important for explaining of hydro-mechanical and mass transport clay's behavior. Our model permits to analyze a lot of interesting hydro-mechanical situations in real clay beds. It's also shown that obtained solutions are in a good harmony with the experimental data.