Contribution ID: **518** Type: **Oral Presentation**

Multicontinuum non-equilibrium theory for coupled flow and deformation in fractured rocks

Monday, 22 May 2023 10:50 (15 minutes)

Coupled flow and deformation in fractured media is often modeled by the classical dual-porosity poroelasticity theory. The latter is based on the Barenblatt hypothesis of pressure equilibrium inside the rock matrix. This is a reasonable assumption if the characteristic time scales for pressure propagation in the matrix are comparable or smaller than the characteristic fracture time scales. Under large permeability contrasts between the fracture and matrix domains, these conditions may not be met, and the flow and deformation behaviors are dominated by non-equilibrium effects, which manifest in long-tails in flux responses. Using volume averaging, we derive a multicontinuum approach that accounts for pressure non-equilibrium in the rock matrix, and compare it to the classial dual porosity approach. We use explicit analytical solutions to identify the dominant time scales and time regimes, and to evaluate the scaling behaviors of the flux response in consolidation and production scenarios. The flux evolution at a production well is characterized by decay behaviors that are different from the classical dual porosity approach. These behaviors are related in the proposed multicontinuum theory to the permeability contrast and the permeability distribution across the matrix blocks.

Participation

In-Person

References

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Session Classification: MS03

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media