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Exploring the limits of semi-analytical matrix diffusion

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Matrix diffusion is a critical process to capture in many subsurface applications in low permeability fractured rocks. In most discrete fracture network (DFN) models, a semi-analytical description of matrix diffusion is adopted in conjunction with Lagrangian particle tracking methods. However, the solutions to semi-analytical matrix diffusion are based on simple fracture networks, i.e., single fractures or multiple parallel fractures where fracture spacing is well-defined. Natural fracture networks can have spatially variable fracture spacing, orientations, and lengths, which could impact the accuracy of semi-analytical matrix diffusion, but has not been quantified to date. In this work we leverage new developments in the dfnWorks software suite to generate discrete fracture matrix (DFM) models to compare solute breakthrough in DFNs with semi-analytical matrix diffusion and DFMs with an explicit description of matrix diffusion. We are able to generate high resolution DFM meshes using a 3D Poisson disc sampling algorithm, where the faces of the fracture mesh conform to the faces of the matrix mesh. Governing equations for flow and transport in the coupled system are solved using the Amanzi Multiphysics code. We first verify the implementation of the explicit matrix diffusion in Amanzi for a single fracture against the semi-analytical solution. Then we systematically increase the complexity of the underlying networks to determine how well the semi-analytical matrix diffusion compares with the explicitly captured matrix diffusion and link the accuracy back to quantifiable fracture network properties.

Participation

In-Person

References

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