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Structure and stochastic dynamics of hydrodynamic flow and transport in three-dimensional random fracture networks

Thursday, 2 June 2022 09:55 (15 minutes)

We study the upscaling and large scale modeling of anomalous transport in three-dimensional random fracture networks. Our approach is based on the continuous time random walk (CTRW) approach, which was pioneered in this context by Brian Berkowitz in his 1997 paper in Phys. Rev. Letters on Anomalous Transport in Random Fracture Networks. Based on detailed flow and particle tracking simulations, we analyze the statistical properties of Lagrangian speeds along individual particle trajectories. Particle transitions are characterized by the conditional probability distribution of subsequent particle speeds separated by different lag distances. We observe that the correlation structure can be described by a Gaussian copula. This finding implies that the particle motion can be described stochastically by a CTRW combined with a Langevin equation for the evolution of particle speeds that is determined by the speed point distribution and correlation length. Mass transfer between the fracture and matrix domains is included in this framework by a compound Poisson process that accounts for particle trapping and retention. The results of the stochastic model are compared to the data from the detailed numerical simulations for solute breakthrough curves and the mean and variance of particle displacements. The model captures all features of anomalous dispersion, and can predict particle transport
for different initial conditions.

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Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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