**Effective pore-scale dispersion – asymptotic and transient behaviour**

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**ABSTRACT:**

We study solute dispersion in an idealized pore network made up of channels with periodically varying apertures. Based on an approximate analytical solution of the flow equation, we study the impact of the geometry and molecular diffusion on effective solute dispersion analytically using the method of local moments and a random walk particle tracking method. For transport in parallel shear flow, the effective dispersion coefficient is dependant on the square of the Peclet number. Here, when the fluctuation of the channel aperture becomes comparable with the channel width, the effective dispersion coefficients show a more complex dependence on the Peclet number and the pore geometry. We find that for a fixed flow rate, periodic fluctuations of the channel aperture can lead to both a decrease and an increase in effective dispersion.

To understand this counterintuitive behavior we model the system using a correlated CTRW approach that provides much insight into the mechanisms driving the observed asymptotic behaviors. Additionally it allows us to accurately predict the pre-asymptotic transient evolution of the dispersion coefficient, something not achievable with the method of local moments alone. We also apply the model to a more realistic pore network that displays many qualitative and quantitative similarities.