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Solute mixing in Darcy-scale heterogeneous porous media: stochastic and interacting dispersive lamellae

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We investigate the mixing dynamics of a large solute plume transported by advection and local diffusion in Darcy-scale porous formations characterized by randomly heterogeneous distributions of hydraulic conductivity. We test the dispersive lamella mixing model for mildly to highly heterogeneous formations. At the core of the dispersive lamella mixing model lays a single non-interacting transport Green function that dilutes according to the effective dispersive scale. This picture falls short in highly heterogeneous formations. Thus, we extend the mixing model to account for the heterogeneity-induced (i) variability in the dispersive behaviors of distinct lamellae (or transport Green functions) and (ii) their interactions. In particular, we relate the latter to the occurrence of strong flow focusing in highly heterogeneous formations and we identify key dispersion-related scales that capture the impact of small and large lamellae interactions on the dynamics of solute mixing.

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References

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