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On the use of random conductivity fields to promote unstable flow of dense plumes

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Abstract Flow under variable-density conditions is widespread, occurring in geothermal reservoirs, at waste disposal sites or due to saltwater intrusions. In nature, the migration of dense plumes typically results in the formation of vertical plume fingers which are known to be triggered by material heterogeneity. Random hydraulic conductivity (K) fields are introduced into numerical simulations to incorporate pore-scale heterogeneity into homogenous media and to generate fingers realistically. That method is evaluated using a previously-conducted laboratory-scale sand tank experiment, which is numerically re-simulated here. Results indicate that the variance of ln(K) of 10^{-3} (K in m s^{-1}) realistically reproduces the number of plume fingers observed in the sand tank experiment. Introducing random K fields is therefore useful to accurately simulate dense plume fingering in saturated homogeneous porous media. A Monte Carlo approach showed that the simulation of dense plume fingers is realisation-independent.

Key words model; groundwater; saturated; density; fingering; random K field; Monte Carlo