USING STREAMLINES FOR HIGHLY-RESOLVED, REACTIVE TRANSPORT CO2 LEAKAGE SCENARIOS TO EXAMINING THE INFLUENCE OF UNCERTAIN SUBSURFACE CONDITIONS ON PROBABILISTIC RISK OF GROUNDWATER CONTAMINATION

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We present a Lagrangian streamline approach where a large, heterogeneous three-dimensional flow field is reduced to a number of one-dimensional transport simulations. The one-dimensional simplification used in the streamline approach allows for fast computational times while conserving complex reactive transport processes over large domains. The ability to accurately model large-scale reactive transport that captures uncertain aquifer conditions has become increasingly necessary in order to evaluate potential groundwater contamination scenarios, such as those associated with CO2 leakage from Carbon Capture and Storage (CCS). The method presented here is well suited to simulate large ensembles to capture subsurface uncertainty.
A CO2 leakage scenario from a hypothetical CCS site is used where a resulting plume of CO2 lowers groundwater pH and mobilizes metals from an existing mineral host-rock distribution to potentially contaminate a drinking water source. In this set of simulations, ensembles of correlated, Gaussian random fields are used to represent heterogeneity in hydraulic conductivity (K) for cases with increasing variance in ln(K). The plume migration and related metal dissolution and precipitation within the aquifer were simulated using the streamline-geochemical modeling approach under varying hydrological heterogeneity variances (σ2lnK). The influence of uncertain hydrological and geochemical characteristics on the probabilistic risk of a drinking water well was examined. Results show that heterogeneity significantly influences geochemical processes and the probabilistic risk of well contamination demonstrating that characterizing aquifer heterogeneity will determine uncertainty.