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Modeling Colloid Transport and Attachment in Variable Aperture Fractures

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A particle-tracking algorithm was developed to simulate colloid transport subject to wall effects on diffusion and colloid surface attachment described by DLVO kinetics. The effects on colloid transport of spatially variable fracture surface potential leading to spatially variable attachment strength are investigated. Surface potential is assigned either positively, not (randomly or zero), or negatively correlated with the lognormally distributed local fracture aperture describe with a mean, variance, and isotropic correlation length. Results indicate that wall effects on diffusion are negligible for the welded, rhyolitic tuff fractures studied here. When the magnitude of fracture surface potential is negatively correlated with local aperture, colloids preferentially transport through the fracture because they tend to enter high-flow, large-aperture regions where they undergo less attachment (have the largest first moment measured upon exit of the first colloid from the fracture). Variances (second moment) increase for flowing colloids when comparing negatively to zero and then positively correlated surface potentials to apertures because spreading notably increases when members of the colloid plume temporarily attach to the fracture surface. For attached colloids, both first and second moments decrease from negatively, zero, and positively correlated surface potentials to apertures, consistent with fewer colloids attaching in the larger-aperture preferential flow paths.