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Monodisperse and polydisperse colloid transport in water saturated fractures with various orientations: Gravity effects

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Numerical experiments are conducted to examine the effect of gravity on monodisperse and polydisperse colloid transport in water-saturated fractures with uniform aperture. Dense colloids travel in water-saturated fractures by advection and diffusion while subject to the influence of gravity. Colloids are assumed to neither attach onto the fracture walls nor penetrate the rock matrix based on the assumption that they are inert and their size is larger than the pore size of the surrounding solid matrix. Both the size distribution of a colloid plume and colloid density are shown to be significant factors impacting their transport when gravitational forces are important. A constant-spatial-step particle-tracking code simulates colloid plumes with increasing densities transporting in water-saturated fractures while accounting for three forces acting on each particle: a deterministic advective force due to the Poiseuille flow field within the fracture, a random force caused by Brownian diffusion, and gravitational force. Integer angles of fracture orientation with respect to the horizontal ranging from $\pm 90^\circ$ are considered, and three log-normally distributed colloid plumes with mean particle size of 1 μm and standard deviation of 0.6, 1.2 and 1.8 μm are examined. Colloid plumes are assigned densities of 1.25, 1.5, 1.75 and 2.0 g/cm^3. The first four spatial moments and the first two temporal moments are estimated as functions of fracture orientation angle and colloid density. Several snapshots of colloid plumes in fractures of different orientations are presented. Results are strongly dependent upon fracture orientation angle. In all cases, larger particles tend to spread over wider sections of the fracture in

the flow direction, but smaller particles can travel faster or slower than larger particles depending on fracture orientation angle.