Colloid transport in water saturated porous media: dispersivity, cotransport and gravity effects

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ABSTRACT

Carefully designed experiments revealed that colloid dispersivity is not only a function of scale, as conventionally assumed, but also a function of colloid diameter and interstitial velocity. It was shown that dispersivity increases linearly with increasing colloid particle size. This phenomenon was attributed to colloid dispersion enhancement due to possible reduction of the effective porosity, which overbalances the reduction of colloid dispersion caused by colloid exclusion from the lower velocity regions (see Fig 1 [1]). A very important implication of this finding is that fitted dispersion coefficients based on tracer data should not be used to analyze colloid experimental data. Additional experiments were conducted under electrostatically unfavorable conditions to investigate the role of gravitational force on colloid transport in water-saturated columns packed with glass beads. The results revealed that flow direction influences colloid transport in porous media. The rate of particle deposition was shown to be greater for up-flow than for down-flow direction, suggesting that gravity was a significant driving force for colloid deposition [2]. Also, we have examined the effect of gravity on virus (MS2) cotransport with clay colloids (KGa-1b, STx-1b) in water saturated vertical columns under two flow directions: upward and downward. The results indicated that KGa-1b hindered MS2 transport while STx-1b facilitated MS2 transport. Finally, a three-dimensional numerical model was developed to investigate the cotransport of dense colloids and viruses in homogeneous, water saturated, porous media with horizontal uniform flow. Model simulations have shown that the presence of dense colloid particles can either enhance or hinder the horizontal transport of viruses, but also can increase the vertical migration of viruses.

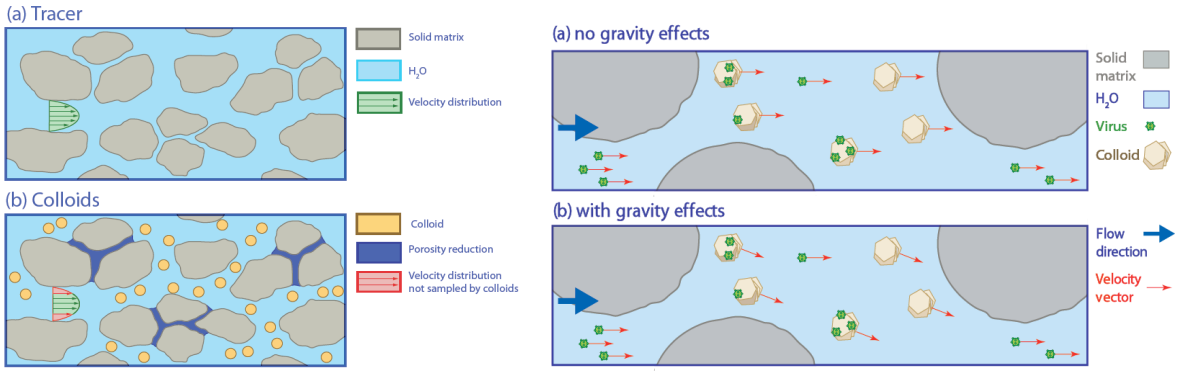

Fig. 1. Schematic illustration of (a) solute conservative tracer and (b) colloid transport in water saturated porous media. The tracer can sample the entire velocity parabolic profile (green region). Colloids do not sample the truncated portion of the parabolic velocity profile (red region). Also, colloids do not enter pore spaces with opening smaller than the colloid diameter, which leads to reduction of effective porosity.
Fig. 2. Schematic illustration of virus and colloid cotransport in water saturated porous media in the: (a) absence, and (b) presence of gravity effects [3].

REFERENCES

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