Introduction

Increasing production and use of fullerene-based nanomaterials is likely to result in their environmental dispersal and subsequent human and ecosystem exposures. A thorough understanding of fullerene transport in the subsurface is essential to assessing environmental fate of fullerenes. To date, few transport studies have used actual environmental media or fullerene derivatives.

In this study, the transport of two fullerene nanoparticles (i.e., aqueous underlying mechanisms were discussed.

Experimental

Instrument and Experimental Methods

Solution Chemistry:

- pH 7.5 – 8.0: 0.4 mM NaHCO₃ + 9.6 mM NaCl
- pH 4: 1.51 mM NaOAc + 10 mM AcOH
- pH 10: 2.5 mM NaHCO₃ + 2.5 mM Na₂CO₃

Results

Measured and fitted breakthrough curves:

- C₆₀ pyrrolidine tris-acid (C₆₀ PTA)
- Aqu/C₆₀
- Ion-exchange of aqu/C₆₀
- Ion-exchange of Aqu/C₆₀

Modeling

- Saturated media
- Unsaturated media

Conclusions

- Fullerene retention increased with increasing grain surface chemical heterogeneity (i.e., amorphous Al oxides/hydroxides in the order of Iota quartz < Ottawa sand < sediment).
- pH dependence of fullerene retention could be partly explained by pH-dependent surface charge of fullerene and grain surfaces, and partly by increased hydrophobicity of fullerene aggregates when solution pH approaches their isoelectric points.
- Fullerene retention was enhanced in unsaturated media, implying that fullerenes can be more attenuated in the vadose zone than in groundwater.