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{Quantification of Colloidal Blocking by Humic Acids in Porous Media

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Humic acids (humics), resulting from the partial decomposition of organic matter, occur widely in nature and form a major constituent of environmental natural organic matter (NOM). Although their ability to promote the dissolution of many substances has been widely recognized, quantification of the influence of humics on the fate and transport of particulate matter has proven less conclusive. One dimensional dynamic column tests involving the injection of suspensions of fluorescence stained 200nm latex microspheres (microspheres) and Suwannee River Humic Acid (SRHA) through columns filled with partly iron-coated quartz sand permitted the influence of humics on colloid deposition in water saturated porous media under controlled conditions to be studied.

Tests consisted of two series of experiments. The first involved the injection of an initial pulse of 13 pore volumes (PV) of 10.4ppm microspheres that resulted in a gradual rise in the colloid's concentration in the column effluent to 8.4% of that injected. Injection of further two identical pulses of 13 PV of colloid, separated by pulses of about 10 PV of colloid-free flushing water resulted in a sustained rise in effluent concentration in the breakthrough of successive pulses. Colloid response, modeled using a random sequential adsorption (RSA) model, suggested that the system required the deposition 1.35×10^{10} colloids on the sand surface for each 1% rise in relative concentration observed in column effluent.

The second series of experiments involved the injection of an initial pulse of 13 pore volumes of colloid suspension followed by the injection of four pore volumes of 5 mg/l SRHA. A mass balance of column effluent suggested that the column retained 98.8% of SRHA injected. Subsequent injection of a second pulse of 13 PV of microspheres saw colloidal concentration breakthrough in column effluent jump to 16% after which it continued to rise at a rate comparable to that in SRHA-free experiments. RSA modeling of colloid response in these latter experiments suggested that 1μg of SRHA could block 4.51×10^{6} colloidal deposition sites. At molecular level, this means that 9.6×10^{7} SRHA molecules block one colloidal deposition site, assuming number average molecular weight of SRHA of 1390g/mol. Study results further highlight the potential of humic acids to promote the transport of natural and anthropogenic substances in groundwater.