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Fate and Transport of Graphene Oxide in Granular Porous Media: Experimental Results and Modeling

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Although graphene oxide (GO) has been used in many applications to improve human life quality, its environmental fate and behavior are still largely unknown. In this work, a range of laboratory experiments were conducted to explore the aggregation, deposition, and transport mechanisms of GO nano-sheets in porous media under various conditions. Stability experimental data showed that both cation valence and pH showed significant effect on the aggregation of GO sheets. The measured critical coagulation concentrations were in good agreement with the predictions of the extended Schulze-Hardy rule. Sand column experimental results indicated that deposition and transport of GO in porous media were strongly dependent on solution ionic strength. Particularly, GO showed high mobility under low ionic strength conditions in both saturated and unsaturated columns. Increasing ionic strength dramatically increased the retention of GO in porous media, mainly through secondary-minimum deposition. Recovery rates of GO in unsaturated sand columns were lower than that in saturated columns under the same ionic strength conditions, suggesting moisture content also played an important role in the retention of GO in porous media. Findings from the bubble column experiments showed that the GO did not attach to the air-water interface, which is consistent with the XDLVO predictions. Additional retention mechanisms, such as film straining, thus could be responsible to the reduced mobility of GO in unsaturated porous media. The breakthrough curves of GO in saturated and unsaturated columns could be accurately simulated by an advection-dispersion-reaction model.