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Dynamics of rare earth element transport and retention in porous media

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The release of Rare Earth Elements (REEs; La-Lu, Y, and Sc) into the environment is becoming unavoidable because of their increasing use in new technologies and products. In this study, we conducted a set of adsorption and column transport experiments in porous media to better understand the mechanisms that control REE behavior in aquifer environments. The retention and mobility of three representative REEs (La, Gd, and Er) were studied at varying concentrations of humic acid (HA; 0, 5, 20, 50 mg L^{-1}) and under a range of environmentally relevant pH values (5-8). Results show that REE mobility and retention are controlled by the amount of REE-HA complexes formed in solution, which increases with HA concentrations and solution pH. Gd is the most mobile among the representative REEs, followed by Er and La, corresponding to the amount of (calculated) REE-HA complexes. Increasing HA concentrations in the REE solution, even with complete complexation of REE-HA, inhibit REE retention and preserve the REE fractionation pattern observed in lower HA concentrations (Gd>Er>La). These results provide a quantitative characterization of REE retention and mobility in porous media. Specifically, REEs are mobile only under specific natural conditions.