Radium adsorption to iron bearing minerals in variable salinity waters

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Radium is a common, naturally occurring radioactive metal found in many subsurface environments accumulating in pore waters from the decay of naturally occurring thorium and uranium. Historically, study of radium in the subsurface focused on the evolution of radon in subterranean settings, such as basements. However, radium isotopes have recently been used as a natural tracers to estimate submarine groundwater discharge (SGD) [1]. Further, they represent a substantial hazard in waste brine produced after hydraulic fracturing for natural gas extraction [2], resulting in a significant risk of environmental release to surface and near-surface waters, as well as increased cost for water treatment or disposal. The variation in radium isotope half-lives and naturally elevated presence in deep groundwater suggest that these isotopes might also serve as markers for historic hydraulic fracturing site contamination.

Adsorption to mineral surfaces represents a primary pathway of radium retention within subsurface environments. For SGD studies, it is important to understand adsorption processes to correctly estimate GW fluxes, while dealing with hydraulic fracturing, radium adsorption to aquifer solids will mediate the activities of radium within produced water and potentially contaminated regions. Some studies of radium adsorption to various minerals have been performed [3], but there remains a limited understanding of the surface chemistry of radium adsorption. In particular, the kinetics and complexation behavior have only been recently investigated [4]. Accordingly, we present the results of sorption experiments of radium to a suite of minerals representative of those found within deep saline and near-surface (freshwater) aquifers, and evaluate impacts of varying salinity solutions through the use of artificial groundwater, seawater, and shale formation brine. Further, we explore the impacts of pyrite oxidation and ferrihydrite transformation to other iron-bearing secondary minerals on the retention of radium. This work lays the groundwork for understanding radium transport in the subsurface, which will allow for better estimation of groundwater fluxes of radium both in submarine settings as well as in case of release of hydraulic fracturing produced waters to the shallow subsurface.

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