Controls on Radium transport by adsorption to iron minerals

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Radium is a naturally occurring radioactive metal found in many subsurface environments. Radium isotopes are generated by uranium and thorium decay, and are particularly abundant within groundwaters where minimal porewater flux leads to accumulation. These isotopes are used as natural tracers for estimating submarine groundwater discharge (SGD) [1], allowing for large scale estimation of GW fluxes into and out of the ocean [2]. They also represent a substantial hazard in wastewater produced after hydraulic fracturing for natural gas extraction [3], resulting in a significant risk of environmental release to surface and near-surface waters, and increased cost for water treatment or disposal.

Adsorption to mineral surfaces represents a dominant pathway of radium retention in subsurface environments. For SGD studies, adsorption processes impact estimates of GW fluxes, while in hydraulic fracturing, radium adsorption to aquifer solids mediates wastewater radium activities. Analysis of past sorption studies revealed large variability in partition coefficients [4], while examination of radium adsorption kinetics and surface complexation have only recently started [5]. Accordingly, we present the results of sorption and column experiments of radium with a suite of iron minerals representative of those found within deep saline and near-surface (freshwater) aquifers, and evaluate impacts of varying salinity solutions through artificial waters. Further, we explore the impacts of pyrite oxidation and ferrihydrite transformation to other iron-bearing secondary minerals on the transport and retention of radium. These results will provide critical information on the mineralogical controls on radium retention in subsurface environments, and will therefore improve predictions of radium groundwater transport in natural and contaminated systems.

[1] Charette, M.A., Buesseler, K.O. & Andrews, J.E., Limnol. Oceanogr. (2001).

[2] Moore, W.S., Ann. Rev. Mar. Sci. (2010).

[3] Vengosh, A. et al. Environ. Sci. Technol.,(2014).

[4] Beck, A., Cochran, M., Marine Chem., (2013).

[5] Sajih, M. et al. Geochim. Cosmochim. AC. (2014).