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## Radium Adsorption to Iron Bearing Minerals in Variable Salinity Waters

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**Abstract Text:**

Radium is a common, naturally occurring radioactive metal found in many subsurface environments. Radium isotopes are a product of natural uranium and thorium decay, and are particularly abundant within groundwaters where minimal flux leads to accumulation within porewaters. Radium has been used as a natural tracer to estimate submarine groundwater discharge (SGD) [1], where the ratios of various radium isotopes are used to estimate total groundwater flux to and from the ocean [2]. Further, it represents a substantial hazard in waste water produced after hydraulic fracturing for natural gas extraction [3], resulting in a significant risk of environmental release and increased cost for water treatment or disposal.

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 in hydraulic fracturing, radium adsorption to aquifer solids will mediate the activities of radium within produced water. While some studies of radium adsorption to various minerals have been performed [4], there is a limited understanding of the surface chemistry of radium adsorption, particularly to iron-bearing minerals such as pyrite, goethite and ferrihydrite. Accordingly, we present the results of sorption experiments of radium to a suite of iron-bearing 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 further study of radium use as a tracer for SGD, as well as understanding mechanisms of radium retention and release from deep aquifer materials following hydraulic fracturing operations.

[1] Charette, M.A., Buesseler, K.O. & Andrews, J.E., Limnol. Oceanogr. 46, 465-470 (2001).

[2] Moore, W.S., Ann. Rev. Mar. Sci. 2, 59-88 (2010).

[3] Vengosh, A., Jackson, R.B., Warner, N., Darrah, T.H. & Kondash, Environ. Sci. Technol., (2014).

[4] Ames, L.L, McGarrah, J., & Walker, B., Clays Clay Miner. 31, 335-342 (1983).

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