Field Assessment and Modelling of Radium Co-Precipitation in Western US Produced Water Streams

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Eighty percent of the United States' produced water, saline water from oil and gas formations brought to the surface during extraction processes often containing high radium concentrations, is generated in States west of the 98th meridian and frequently discharged to surface waters through the National Pollutant Discharge Elimination System (NPDES)[1]. Recent radium studies lack a focus on Western States where surface disposal of oil and gas produced water is more commonly practiced and beneficial reuse permit exemptions for irrigation and agricultural livestock watering allow minimal treatment prior to surface disposal.

Water and sediment grab samples were collected twice in 2016 at 26 sites along two perennial rivers and one ephemeral tributary in a remote region of Wyoming, including upstream and downstream of seven NPDES discharge facilities. Geochemical modelling indicated super-saturation of carbonate and sulfate minerals such as calcite, barite, and dolomite near facilities. Sediment samples at the point of discharge were elevated in total radium, with one facility as high as 96 pCi/g (3552 Bq/kg). Initial X-Ray Diffraction analysis indicates sediments are >95% calcite and initial grain size analysis (coarse sand, fine sand, and silt/clay) indicates an equal distribution of radium concentrations as opposed to a study in Pennsylvania that observed increasing association of radium with decreasing grain size [2]. Leaching experiments to determine radium co-precipitation will be completed to determine the specific mineral co-precipitation mechanism as well as utilizing novel PHREEQC modelling for radium adsorption to ferrous and manganese oxides.

[1] K. Guerra, K. Dahm, and S. Dundorf, "Oil and gas produced water management and beneficial use in the Western United States," no. 157, 2011. [2] K. Van Sice, C. Cravotta, B. McDevitt, T. Tasker, N.R. Warner, "Radium fate following oil and gas wastewater disposal to western Pennsylvania surface waters," unpublished.