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Nitrate and microbial metabolism impacting geogenic uranium groundwater contamination in alluvial aquifers

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Geogenic uranium contamination has been recognized to impair groundwaters globally threatening drinking water serving urban and rural populations. Mobilization of naturally-occurring uranium(U) has been recognized to give rise to geogenic U groundwater contamination in aquifers. In addition to carbonate ligand complexation, a common anthropogenic groundwater contaminant, nitrate, has been demonstrated to play a role in controlling U mobility by altering uranium solubility through redox reactions in alluvial aquifers. Alluvial deposition processes that form these aquifers create a lithologic ally heterogeneous subsurface with defined interfaces between sands, silts, and clays. This leads to deposition of organic carbon and accumulation of reduced metals/radionuclides, including U(IV), in the finer grained silts and clays. Nitrate is often prevalent at high concentrations in groundwaters within these alluvial aquifers overlaying managed lands. The addition of high nitrate porewater into uranium-bearing alluvial aquifer silt sediments stimulated a nitrate reducing microbial community capable of mediating U(IV) oxidation and mobilization of U into porewaters. This can occur through direct microbial oxidation of U(IV) coupled to nitrate or through the microbial production of a reactive intermediates, nitrite, which was subsequently demonstrated to abiotically oxidize U(IV). Thus experimentally demonstrating that influxes of nitrate into aquifers where U(IV) is deposited poses a risk to the long-term sequestration of sedimentary associated uranium resulting in geogenic uranium groundwater contamination within alluvial aquifers.