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Subsurface uranium and technetium reduction and sequestration through liquid-phase chemical reduction and sequestration amendments

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There is a need to develop remediation technologies targeting sequestration of commingled contaminants where complex waste streams have been historically released to the subsurface, including sites like the Hanford Site in southeastern Washington state. At the Hanford Site, uranium and technetium-99 are among the primary contaminants for remediation in the deep vadose zone; however, they are present alongside other contaminants including strontium-90, iodine-129, hexavalent chromium, and nitrate. Sequestering and immobilizing these contaminants poses a significant challenge. Herein, different combinations of amendments were investigated for their ability to immobilize contaminants in sediments via reduction and apatite formation, including (i) polyphosphate (Poly-PO_4) to form apatite, (ii) calcium citrate phosphate (Ca-Cit-PO_4) to stimulate reducing conditions via local microbes and form apatite, (iii) calcium polysulfide (CPS) and Poly-PO_4 to generate reducing conditions and form apatite, respectively. The objective was to reduce contaminants to lower solubility oxidation states and then coat precipitates and adsorbed phases with apatite to reduce long-term re-mobilization. Batch experiment results showed that the combination of CPS and Poly-PO_4 as well as the Ca-Cit-PO_4 technologies were effective for both uranium and technetium-99 with > 60% immobilized under all conditions, including when co-contaminants were present. However, Poly-PO_4 was only effective for uranium highlighting the need for a reductant to sequester technetium-99. Future work will focus on investigating additional site-specific conditions, examining the effects of all the co-contaminants on U and Tc-99 sequestrations, and scaling experiments for pilot scale testing.