Sulfide and iron work together to reveal a new path for radionuclide sequestration

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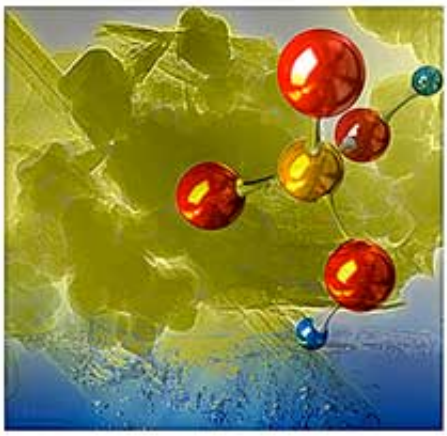

Sifting radionuclides with sulfur: Technetium sequestration pathways under sulfidogenic conditions stimulated by nZVI offer a possibly more sustainable, environmentally friendly approach to bioremediation.

As an ongoing concern for the Department of Energy's Office of Biological and Environmental Research (DOE-BER), bioremediation strategies that either remove contaminants or retard their mobility in the environment are long-sought-after solutions. Technetium-99, an isotope generated from nuclear fission stemming from Manhattan Project-era plutonium processing, is among the high-priority radionuclides requiring environmental controls.

In one approach to tackle this problem, scientists measured reduction of

soluble pertechnetate ($^{99}TcO_4$?) by nano zerovalent iron (nZVI) that had been pre-exposed to sulfide (S^{2-}) in simulated Hanford Site groundwater. nZVI promotes microbial reduction of sulfate (SO_4^{2-}) to S^{2-} and offers a promising and sustainable method for generating S^{2-} in the environment.

Their work, using a mix of microscopy-, diffraction-, and spectroscopy-aided assessments and conceptual modeling, was designed to provide a fundamental geochemical understanding of Tc sequestration as new sulfide compounds developed in the presence of nZVI, as well as offer an alternative remediation strategy. The scientists examined the evolution of mineral phases during the changing sulfidation states using a mix of EMSL's capabilities and X-ray absorption spectroscopy (XAS) at the Stanford Synchrotron Radiation Lightsource (SSRL).

They coupled this work to Tc sequestration kinetics under incremental sulfur/iron ratios. Their results showed the importance of iron sulfide in Tc sequestration and how sulfidation of nZVI can direct TcO_4? sequestration products from Tc(IV) oxide—which is highly susceptible to reoxidation—to Tc(IV) sulfide phases, providing a more favorable sequestration pathway.

More information: Fan, D. et al. 2013. Reductive Sequestration of Pertechnetate ($^{99}TcO_4$–) by Nano Zerovalent Iron (nZVI) Transformed by Abiotic Sulfide, *Environmental Science & Technology* 47(10):5302-5310. DOI: 10.1021/es304829z.

Provided by Environmental Molecular Sciences Laboratory

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