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Assessment of manganese oxides for the sorption of radionuclides  
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Recent research has shown that certain manganese oxides have the ability to sorb aqueous metal cations much more efficiently than any of the naturally occurring iron oxides when normalized to surface area. This ability is, at least in part, related to the internal sites available in many manganese oxide structures, including those within tunnels and between sheets. Additionally, a new naturally-occurring manganese oxide structurally related to vernadite ( $\delta\text{-MnO}_2$ ), collected along the Clark Fork River in western Montana, USA, has shown the ability to sorb arsenate, an anionic complex. The potential for manganese oxides to sorb anions has made it an attractive material as a radionuclide "getter."

According to the U.S. Department of Energy's Total Systems Performance Assessment, technetium and iodine are two major anionic radionuclides contributing to the list of potential contaminants released from Yucca Mountain repository, Nevada, USA. These two radionuclides are extremely problematic because they are very mobile in the environment. This project involves running flow-through sorption experiments using rhenium (a surrogate for technetium) and stable iodine as sorbates and several synthetic manganese oxides, including birnessite, vernadite, cryptomelane, and possibly the new vernadite-like phase mentioned earlier, as sorbants.

For all synthesis reactions, manganese (VII) salts are reduced to manganese (III,IV) oxides. The different oxides are produced from specific reductants and/or the addition of heat, followed by multiple washing steps. To verify that the proper phases have been synthesized, all oxides are analyzed using transmission electron microscopy (TEM) and powder X-ray diffraction (XRD). The sorption experiments will be run in flow-through reactors bearing the aqueous complex of interest, where solutions, at various temperatures, pH's, and ionic strengths, will pass through a bed of one of the manganese oxides. The effluent solution will be analyzed using aqueous spectroscopic methods and the reacted solids will be analyzed using microscopy (field emission scanning electron microscopy, FE-SEM; and TEM), structure analysis (XRD), bulk chemical spectroscopy (energy dispersive spectroscopy, EDS), and surface sensitive spectroscopy (X-ray photoelectron spectroscopy, XPS).