

## **Precipitation Kinetics of Autunite Minerals: Implications for Uranium Immobilization**

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As we begin a shift to non-fossil energy sources, nuclear power has great appeal, as it does not contribute to climate change. Future expansion of nuclear power will drive the need for uranium mining. Legacy contamination of sediments and water by uranium is a significant problem throughout the world, and to avoid repeating these mistakes, it is critical to develop technical solutions to ensure the safe production of uranium in order to minimize human and ecological health effects.

One promising technology to inhibit uranium transport in groundwater is the use of subsurface permeable reactive barriers. Materials currently under investigation include apatite. Phosphate released from apatite dissolution reacts with uranium to precipitate uranyl phosphate minerals such as those of the autunite group. This project will study geochemical controls on autunite precipitation, providing insight into the kinetics of this reaction and the process by which the mineral nucleates and grows.

Laboratory experiments will use an autunite seed to further mineral growth in a temperature-controlled mixed-flow reactor. Uranium, calcium, and phosphate concentrations from feed and effluent solutions will be used to calculate mineral precipitation rates. The nucleation of autunite minerals will be observed using an atomic force microscope equipped with Raman spectroscopy, allowing real-time chemical observation. Data from this project will be used in a future project to model dissolution and precipitation of uranium minerals at the Coles Hill Uranium Deposit in Virginia. At this site, autunite group minerals have formed and exhibit long-term stability in the saturated zone above the ore deposit.