Phosphate effect on uranium release from acidic reacted Hanford sediments

WOOYONG UM[1,*], GUOHUI WANG[1], NANCY M. WASHTON[1], KARL T. MULLER[1], AND JON CHOROVER[2],

[1]Pacific Northwest National Laboratory, Richland, USA
[2]University of Arizona, Tucson, USA

Introduction

At Hanford site (WA, USA), the 216-U-8 and U-12 Cribs located in the 200 West Area received acidic process condensate from different sources. The phosphate content of these sources is expected to inhibit long-term uranium release from sediment exposed to acidic reaction. To investigate this effect, two acidic, nitrate-containing waste simulants were prepared with and without phosphate and reacted with Hanford vadose zone sediment for 3-15 months. Characterization of the reacted sediment identified two different uranium mineral phases, meta-ankoleite ($K[UO_2][PO_4]•3H_2O$) in the sediments reacted with phosphate containing simulant and becquerelite $[Ca(UO_2)_6O_4(OH)_6•8(H_2O)]$ in the sediments reacted with phosphate-free simulant. Uranium release from the reacted sediments was then investigated for 120 days using the flow-through cell test with synthetic Hanford background pore water (BPW) to understand the phosphate effect on uranium releases.

Results

No significant difference in uranium release was observed between sediments reacted for 90 and 450 days with phosphate-free simulant, implying that uranium phase stabilization occurred by 90-day reaction. However, for samples reacted with phosphate-containing simulant, the uranium release from the 450-day sample was ~40% lower than the 90-day sample, where the extended reacting time could produce larger particle sizes or more crystalline meta-ankoleite. Insoluble uranium phosphate phases (meta-ankoleite) strongly retained uranium in the reacted sediments, even after 120 days of leaching by BPW (Fig. 1).

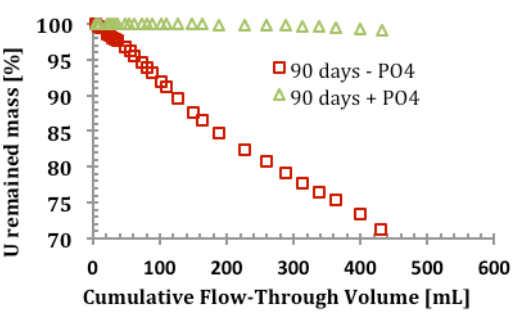

Fig.1. Uranium released mass (%) as a function of leaching volume (3.5 mL/day) for 90-days reacted sediment with ($+PO_4$) and without phosphate ($-PO_4$)

The presence of phosphate minimizes uranium release through rapid precipitation of insoluble meta-ankoleite,