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Improvement of the stability of IO_3^--, SeO_3^{2-}-, and SeO_4^{2-}-coprecipitated barite after treatment with phosphate

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Currently, coprecipitation of radionuclides with barite has been studied to remove radionuclides from radioactive liquid waste. While much is known on the excellent removal efficiency of barite coprecipitation method, little information exists concerning the stability of the ions coprecipitated with barite. This study systematically investigated the stability of iodate (IO_3^-), selenite (SeO_3^{2-}), and selenate (SeO_4^{2-}) coprecipitation with barite. Iodine-129 and selenium-79 are long half-life fission products of uranium-235 and mainly exist as oxyanions in liquid nuclear wastes, and these oxyanions are highly soluble in water and thus mobile in the geological environment.

These oxyanions were gradually released into ultrapure water with time. Leaching of the oxyanions significantly increased in leaching solutions containing NaCl, $NaNO_3$, and Na_2SO_4. Conversely, leaching of the oxyanions was suppressed in KH_2PO_4 solution, indicating that phosphate stabilized the oxyanion-bearing barite. The effect of phosphate treatment on oxyanion-bearing barite was further investigated. The results showed that the barite surface was modified with phosphate, and a thin surface layer of a barium phosphate-like structure was formed. The amount of oxyanions leached from the phosphate-treated samples into leaching solutions containing NaCl and $NaNO_3$ was much lower than that from the untreated samples into ultrapure water.

Hence, a considerable improvement in the stability of iodate, selenite, and selenate coprecipitated with barite can be achieved using phosphate as a stabilizing reagent. The barite structure becomes unstable by incorporating non-component anions into the structure; however, the barite surface structure can be stabilized after the phosphate treatment via the formation of a stable surface layer by the binding of phosphate to the barite surface. Therefore, the barite coprecipitation combined with subsequent phosphate treatment may be a promising method to efficiently remove radioactive iodate, selenite, and selenate from wastewater and stabilize them as barite coprecipitates. To the best of our knowledge, this is the first study to demonstrate the effect of phosphate on the stabilization of the barite surface structure and its application for the development of geological repositories.