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An apatite for iodine: How apatite can incorporate iodine for the use in spent nuclear fuel backfill materials

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Iodine-129 (^{129}I) has a high radiotoxicity even at low concentrations and a long half-life (15.7 million of years), which corroborates the importance of immobilization of this nuclide [1]. Deep geologic storage is the most likely solution for isolation of spent nuclear fuel (SNF) for preventing environmental contamination. Bentonite, a material proposed for development of engineering barriers, absorbs various cationic nuclides but is not as effective for common ^{129}I anions (iodide and iodate).

Our experiments showed that apatite entraps up to a few wt.% of iodate from aqueous solutions at ambient and hydrothermal conditions. The degree of this entrapment was found to increase by over an order of magnitude with decreasing the iodate concentration in the fluid from 1270 ppm to 32 ppm, which corroborates an importance of apatite in immobilization of ^{129}I. We crystallized apatite in iodine bearing solutions at temperatures ranging from 40˚C to 200˚C, which are expected at disposal sites in the proximity and at the distance from SNF canister. Experimental products (crystals and fluids) were characterized with a variety of spectroscopy and mass spectrometry techniques for quantifying iodine uptake as well as characterizing its positioning within apatite structure.

References:

[1] Kaplan, D I et al. “Radioiodine Biogeochemistry and Prevalence in Groundwater.” *Critical reviews in environmental science and technology* vol. 44,20 (2014): 2287-2335.doi:10.1080/10643389.2013.828273