Desorption of Plutonium from Altered Nuclear Melt Glass Colloids

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Highly radiotoxic plutonium (Pu) has been introduced into the environment and transported by groundwater at sites of nuclear weapons' testing (e.g., Nevada National Security Site, NNSS, USA). In the case of underground nuclear testing, high temperatures lead to the formation of melt glass that sequesters a large fraction of the plutonium source. In the presence of water, hydrothermal glass alteration takes place. Thus, Pu migration will be controlled by the rate of glass alteration, the resulting Pu release, and colloid-facilitated transport. In particular, the association of Pu with colloids produced as a result of glass alteration will have a significant impact on the transport behavior of Pu.

To evaluate the nature of Pu association with glass alteration products, nuclear melt glass from NNSS was hydrothermally altered at 25 to 200 °C for about 994 days. During this time, the colloidal load of the suspension increased and secondary solid phases consisted primarily of plutonium-containing smectite and zeolite minerals. In follow-on experiments, flow-cell desorption experiments using these glass alteration colloids were conducted. The results are being modeled by applying our recently developed numerical model for Pu-montmorillonite adsorption/desorption.[1] To date, the results suggest that hydrothermal alteration of nuclear melt glass produces colloids with adsorbed Pu that can desorb according to kinetics established by detailed Pu-montmorillonite adsorption/desorption experiments. However, a fraction of Pu may be sequestered by the clay colloids, possibly via structural substitution. This fraction may be permanently associated with colloids and may, as a result, have much greater migration potential.

[1] Begg, J.D., M. Zavarin, and A.B. Kersting, *Geochim. Cosmochim. Acta*, 197, 278–293 (2017).