The influence of colloids on the mobility of rare earth elements in mine waters

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Ultrafiltration and the capture and characterization of colloids provide an opportunity to assess the role of colloids in transporting rare earth elements (REEs) in mine waters. We have studied REE-bearing colloids in waters associated with tailings from an unmined REE deposit, and in drainage downstream of a former uranium (U) mine. Tailings with REEs hosted in zircon, fergusonite, allanite, monazite and bastnäsite were mixed with three waters: distilled deionized (DI) water, simulating tailings flooded by rain or snowmelt; lake water from the disposal site; and plant water to be co-deposited with the tailings. Thirty mL of each solution were filtered to <0.45 μm and then to <0.01 μm. Filters were examined by scanning electron microscopy and synchrotron-based microXRF and microXRD. At 21°C, most (85%) of the total REEs in the DI solution filtered to <0.45 μm were associated with colloid-sized REE ore minerals from fine grinding. Less (44%) of the total REEs were colloidal in lake water, and even less (10%) in plant water, indicating that aqueous solutions of higher ionic strength have more truly dissolved REEs due to complexation with various ligands. The colloids captured on the 0.01 μm filters from the lake and plant water were Fe and Mn oxyhydroxides. In the second study, 20 L samples of stream water were collected downstream from a U tailings impoundment, filtered to <0.45 μm during collection, and later ultrafiltered to <0.005 μm using a tangential flow filtration system. The retentate was centrifuged to concentrate the colloids for analysis. Results indicated that REEs are present in both the dissolved and colloidal fractions, but their downstream mobility is limited by sorption to Fe and Mn colloids. Conventional filtration of mine waters to 0.45 μm and the assumption that REEs in these filtrates are dissolved may overestimate the amount of REE likely to be mobile or bioavailable.