Speciation of REE in mine tailings from the Nechalacho deposit, NWT, Canada

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The objective of this research is to understand how rare earth elements (REEs) may be mobilized by interaction of aqueous solutions with pilot plant tailings from a proposed mine. The deposit is hosted within a hydrothermally altered layered nepheline-sodalite syenite. The tailings consist of K-feldspar, albite, quartz, biotite, and Fe-oxides with <5% of the ore minerals: zircon, fergusonite, allanite, monazite, bastnäsite. A series of shake flask tests were used to mix Nechalacho pilot plant tailings 3 to 1 by weight with 3 different waters: distilled deionized water (pH 5, ionic strength $I = 0$), lake water (pH 8, $I = 0.005$), and water from the pilot plant processing (pH 8, $I = 0.05$). The flasks were gently agitated on an orbital shaker at 150 rpm for 24 h at both 25°C and 4°C. For environmental assessment, metals in solutions filtered to 0.45 μm are usually considered to be dissolved and potentially bioavailable. For our experiments, the decants were first filtered at 0.45 μm, then at 10 nm, with the total REEs in the two filtrates varying between the three water types: DI water (12 μg/L REE <0.45 μm; 0.8 μg/L <10 nm), lake water (3 μg/L; 1 μg/L), and water from pilot plant processing (5.5 μg/L; 4 μg/L). The [REE] in the colloidal phase ($[REE]_{colloids} = [REE]_{0.45} - [REE]_{0.01}$) increased with decreasing ionic strength, while the [REE] in the dissolved fraction (10 nm filtrate) increased with increasing ionic strength. For example, 90% of the Ce was colloidal in the DI experiment, 80% in the lake water, and 50% in the pilot plant water. The 10-nm filters were examined by scanning electron microscope and synchrotron-based microXRF and microXRD. Those from the DI experiments contain fine ore particles, while those from lake and pilot plant water contain Fe and Mn oxyhydroxides. Of the REEs that do occur in the dissolved phase, aqueous speciation modelling indicates that only a small fraction (< 1%) will occur as free ions, generally considered the bioavailable fraction. These results suggest that REEs are not easily leached from these ore minerals, but concentrations of REEs present as tiny ore particles or colloids may appear to be dissolved in aqueous solutions filtered to <0.45 μm.

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