Zinc isotope partitioning in organic substrate-amended mine tailings

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Zinc isotope ratios were determined to examine partitioning linked to (bio)geochemical processes in organic carbon amended tailings at the Greens Creek Mine (Alaska, USA). Tailings were amended with various substrates to promote sulfidogenesis, alkalinity production, and metal attenuation. Extensive sulfate reduction, metal removal and alkalinity production were observed within a test cell amended with 5 vol. % peat + spent brewing grain (TC4). In contrast, sulfate reduction and alkalinity production were limited in a control cell (TC2). Maximum Zn concentrations of 320 mg L^{-1} (TC4) and 97 mg L^{-1} (TC2) occurred within 25 cm of the tailings surface. Minimum pH values of 6.9, which are indicative of sulfide mineral oxidation, were also observed within this zone. Zinc concentrations declined rapidly with depth in both cells; however, values consistently < 1 mg L^{-1} at depths > 50 cm within TC4 were attributed to the formation of secondary Zn sulfides. In contrast, Zn mobility within TC2 was controlled by sorption onto metal (hydr)oxides and carbonate precipitation. Zinc isotopes within the upper 25 cm of both TC2 and TC4 were enriched in ^{66}Zn, with $\delta^{66}Zn_{IRMM}$ values ranging from +0.29 to +0.30 ‰. Depleted ^{66}Zn isotope ratios (Δ = 0.3 ‰) corresponded to Zn removal within TC4, whereas Zn isotope partitioning was limited within TC2. Results suggest, that $\delta^{66}Zn$ may be indicative of (bio)geochemical processes that control Zn mobility.