

Zn isotope systematics in contrasting Deccan basalt weathering profiles

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In terrestrial ecosystems, (a)biotic chemical reactions within the “Critical Zone” (CZ) control the exchange and release of nutrients [1]. Because Zn is an important vital micronutrient, studies of deep weathering profiles across the CZ are useful to quantify Zn exchange, the key release reactions and the overall export of Zn to the oceans. Here we report combined high-precision geochemistry and mineralogy from two contrasting Deccan basalt weathering profiles to compare soil development processes of the deeper CZ (*i.e.* Chhindwara saprolite) and an upper highly weathered CZ (*i.e.* Bidar laterite) in India. According to our data, ca. 35% of Zn are released during clay mineral formation in saprolite, whereas enhanced formation of Fe-oxyhydroxides results in a Zn release of 80% from laterite.

Zn isotope systematics within weathering profiles are relatively unexplored but have clear mineralogic and chemical differences between saprolite (clays) and laterites (oxi-hydroxides). In the saprolite, $\delta^{66}\text{Zn}_{\text{JMC-Lyon}}$ is slightly heavier than the protolith, without, however, departing from the “crustal average” of $\delta^{66}\text{Zn}$ ($0.27 \pm 0.07\text{‰}$) [2]. By contrast, in the Fe-oxihydroxide dominated horizons, strong isotopic depletion of up to $\sim -0.65\text{‰}$ is evident. Considering results of experimental studies, the intensity of fractionation is likely controlled by biotic and kinetically controlled sorption reactions on oxide surface sites. Additionally, the incorporation of lighter Zn isotopes into the oxyhydroxides during profile development cannot be ruled out, although this process currently lacks experimental data. Regardless, the isotopic fractionation of Zn in the Bidar laterite suggests that very specific levels/horizons in sub-(tropical) weathering profiles may exert a control on riverine Zn isotope compositions, whereas the continental nutrient supply of Zn from the deeper CZ to rivers and oceans is unlikely to be accompanied by enhanced isotopic fractionation. [1] Brantley et al., 2007 *Elements* 3(5), 307-315. [2] Little et al. (2016) *Geology* 44, 207-210.