Zinc isotope fractionation during lateritic weathering

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Zinc (Zn) isotopes are currently being explored for a variety of applications within the Earth Sciences. One focus has been to use isotopes to improve constraints on the modern fluxes of Zn to and from the ocean [1]. The riverine flux of zinc (Zn) is a key component of the Zn oceanic mass balance [1]. Most studies to date suggest that weathering does not impart a significant Zn isotope fractionation on the dissolved phase in rivers [1, 2]. However, only two studies have investigated the isotopic fractionation of Zn associated with (sub-)tropical weathering [3, 4], and none have investigated Zn isotope fractionation associated with the formation of laterites, which are the product of high intensity (sub-)tropical weathering of iron-rich protoliths.

We present double spike Zn isotope data for a well-characterised laterite profile form India that formed during the Miocene (~10-20 Ma). Calculated tau-values for Zn (τ_{Zn}, relative to the immobile element Nb) show a general pattern of Zn loss up-section from unaltered greywacke protolith to intensely altered indurated laterite duricrust. A systematic Zn isotope shift of ~0.6‰ is observed between unaltered greywacke ($\delta^{66}Zn_{JMC\text{-}Lyon}$ = +0.50 ± 0.08‰) and indurated laterite cap ($\delta^{66}Zn$ = –0.12 ± 0.08‰).

We observe, therefore, that Zn isotopes are fractionated by extreme tropical weathering, with preferential release of heavy Zn. This is consistent with observations for tropical soils in Cameroon [3] and for sub-tropical weathered shales from China [4]. We suggest that the shift to lighter $\delta^{66}Zn$ values in strongly weathered environments reflects the preferential removal of isotopically heavy Zn complexed to aqueous organic ligands. Given that ~50% of continental surface waters flow across laterite-covered terrain [5], this process may play a role in setting riverine Zn isotope values and ultimately the Zn isotopic composition of the oceans, particularly during geeological time periods favourable for lateritic weathering.

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