

Sr isotope fractionation as a function of the denudation regime

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Weathering and erosion processes in the Critical Zone (CZ) can be fingerprinted using the stable isotope ratios of metals (for example Li, Mg, Ca, Fe, Sr) and metalloids (B, Si). Using mathematical frameworks, predictions can be made about the isotope signatures of the CZ compartments, such as primary minerals, secondary weathering products, organics, bulk soil, or species dissolved in soil and river water [1]. The predicted isotope signatures depend on (a) the geochemical behaviour of the considered element and (b) the denudation regime under which the considered system is operated. Conversely, denudation regimes can be traced - including in the past - using isotope signatures of CZ zone compartments, in particular river water [2]. Here we examine how the stable isotope of strontium ($^{88}\text{Sr}/^{86}\text{Sr}$) fractionate in the CZ as a function of the denudation regime. For this, we report the Sr isotope composition ($\delta^{88}\text{Sr}$) of the CZ compartments across three field sites encompassing a range of denudation regimes. At all sites, Sr isotopes are fractionated by (a) uptake by vegetation and (b) incorporation into clays. We provide field-based estimates of the Sr isotope fractionation factors associated with these processes. However, the Sr isotope fractionation is not manifested in the dissolved load of the rivers draining these field sites, as shown by the similarity between the river dissolved $\delta^{88}\text{Sr}$ and the source $\delta^{88}\text{Sr}$ (rock + atmospheric inputs). This is consistent with the fact that Sr is soluble element, easily released from secondary, isotopically fractionated weathering products (clays and organics), upon sufficiently long interaction times between solids and water. This also suggests that Sr isotope fractionation in river dissolved load will be observed only for very high-denudation regimes, where the transit of material through the CZ is fast enough to allow for secondary, isotopically fractionated weathering products to be preserved and exported. We extend our analysis to large rivers, using previously published data [3], and show how river dissolved $\delta^{88}\text{Sr}$ is linked to the denudation regime

[1] Bouchez et al., *Amer. J. Sci.* **313**, 2013.

[2] Dellinger et al., *GCA* **164**, 2015.

[3] Pearce et al., *GCA* **157**, 2015