Calcium Isotopic Compositions of a Carbonate Weathering Porfile in Southern China

XIN LI, FANG LIU, YAJUN AN, GANGJIAN WEI, JINLONG MA AND ZHAOFENG ZHANG

State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Guangzhou 510640, China

Calcium isotopic compositions of a carbonate weathering profile have been investigated to understand the behavior of Ca isotopes during carbonate weathering in Southern China. Compared to the bedrock ($\delta^{44/40}$Ca = 0.76‰), $\delta^{44/40}$Ca values of the overlying weathering materials are progressively decreasing with the increasing weathering intensities towards the surface of the profile. Calcium isotopes are greatly fractionated in the upper section with $\delta^{44/40}$Ca ranging from -0.44 ± 0.12‰ to 0.53 ± 0.07‰, possibly reflected adsorption and/or ion-exchange by clay minerals and/or organic materials. In the middle section, $\delta^{44/40}$Ca values keep relatively constant in a limited range 0.59 ± 0.04‰ to 0.65 ± 0.06‰ with an average of 0.62 ± 0.06‰ despite of repeated carbonate dissolution-reprecipitation processes. In the lower section close to the bedrock, $\delta^{44/40}$Ca values show a limited variation ranging from 0.64 ± 0.15‰ to 0.73 ± 0.01‰, slightly lower but within the range of that of the bedrock.

It can be concluded that local atmospheric inputs are unable to change calcium isotopic compositions of the weathering profile. The results in the middle section observed no calcium isotopic fractionation, this could be true because congruent carbonate dissolution and/or low reprecipitation rate are not able to induce significant isotopic fractionation. Instead, calcium isotopic compositions obtained in the upper section are mainly controlled by adsorption and/or ion-exchange on clay minerals or organic matters, and the exchange capacity is pH-dependent. Our model indicated that calcium loss during weathering general follows Rayleigh distillation law with an apparent fractionation factor (α) between fluid and residue of 1.00005 to 1.0002. Our results highlight that, light isotopes, at least for calcium, are preferentially adsorbed on the clay minerals while heavy isotopes are progressively released into the hydrosphere during carbonate weathering, suggesting that calcium isotopes could be a good candidate of climate indicators to trace weathering intensities over the history of the Earth.