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Fractionation of stable isotopes of strontium in continental carbonate environments as a potential contributor to the $\delta^{88/86}$Sr in the oceans

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Several fluxes dictate the concentration and isotope composition of strontium in the oceans including: continental crust weathering, the hydrothermal flux and the precipitation of marine carbonates. These fluxes were traditionally evaluated by the radiogenic ratio of ^{87}Sr/^{86}Sr and recently by the stable isotope ratio of ^{88}Sr/^{86}Sr. In this study the Sr fractionation in carbonate continental environments were investigated in order to evaluate the continental weathering ^{88}Sr/^{86}Sr component.

The $\delta^{88/86}$Sr values of mountain soils along a precipitation gradient and their parent desert dust were analyzed, as well as the $\delta^{88/86}$Sr values of continental waters that precipitated carbonate minerals. Isotopic measurements were conducted by MC-ICP-MS using double-spike method to correct for the instrumental mass bias.

The results show that the desert dust and all mountain soils have a similar $\delta^{88/86}$Sr values. These results suggest that there is no significant Sr isotope fractionation during weathering (including leaching and dissolution). In contrast, we found significant Sr isotope fractionation during precipitation of continental solid carbonates. Speleothems and tufa were isotopically depleted with respect to the dripping and stream waters from which they precipitated. The $\Delta^{88/86}\mathrm{Sr}_{carb-water}$, the average isotope fractionation factor between the solid carbonate and the conjugate water was found to be -0.20$\pm$0.08‰ (2SD, n=5). This fractionation factor is similar within 2SD to the previously published $\Delta^{88/86}\mathrm{Sr}_{carb-water}$ for precipitation of marine carbonates ($\Delta^{88/86}\mathrm{Sr}_{carb-sw}$=-0.24‰). The continental carbonate precipitation is substantially smaller than the marine carbonate deposition and hence has a little impact on the Sr isotopic composition of the continental runoff into the oceans.

Our results indicate that $\delta^{88/86}$Sr value of the continental flux to the ocean is predominantly dictated by the relative contribution of Sr derived by weathering of two end members: silicates with $\delta^{88/86}$Sr of $\approx$0.27‰ and isotopically depleted carbonates. Hence, the variations in the weathering terrains during geological time play a major role in controlling the secular variations of the Sr isotopic composition of the oceans.