

Stable Sr isotope fractionation between fluids and clay minerals: Insight from laboratory batch experiments

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Preferential removal of isotopically lighter Sr from aqueous phases by adsorption onto phyllosilicate clay minerals and iron oxides have been observed in many catchment studies. However, at this stage, it is not straightforward to assess the effect of the adsorption process on Sr isotope fractionation through field studies because the fractionation may be attributed to multiple factors. To better constrain the adsorption process on exogenic Sr cycling, a time-series monitoring of laboratory batch experiment (from 0 to 24 hours) was conducted at 25°C and a pH of ~5 to evaluate the possible Sr isotope fractionation during the adsorption/desorption processes onto/from phyllosilicate clay minerals. Experiments showed that isotopically heavier Sr was preferentially released from smectite during the extraction experiments ($\Delta^{88/86}\text{Sr}$ could be as large as 0.20‰); in contrast, isotopically lighter Sr was preferentially adsorbed onto smectite during the adsorption processes ($\Delta^{88/86}\text{Sr}$ could be up to 0.17‰). $^{87}\text{Sr}/^{86}\text{Sr}$ data indicates that the exchange of Sr, between the aqueous phase and the mineral phase, reaches equilibrium in less than 30 mins. After equilibrium, lighter Sr isotopes were adsorbed onto smectite and the size of fractionation ($\Delta^{88/86}\text{Sr}_{\text{fluid, initial-final}}$) attained constant values of $-0.16\text{‰}\pm 0.03\text{‰}$. This size is comparable with the $\Delta^{88/86}\text{Sr}_{\text{calcite-fluid}}$ of $-0.17\text{‰}\pm 0.07\text{‰}$ [1] caused by secondary calcite precipitation in rivers and cannot be ignored in the catchment scale. This study demonstrates the potential Sr isotope fractionation caused by adsorption processes on a laboratory scale, a comprehensive evaluation in the field catchments will be explored in future studies.

[1] Liu et al. (2017), *Chemical Geology* 456, 85-97.