Experimental investigation of Mg isotope fractionation during mineral dissolution and clay formation

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Silicate minerals are a major Mg source to seawater through rivers and therefore it is important to determine the impact of dissolution and formation of Mg-rich primary and secondary minerals on the Mg isotope signature of natural waters. We dissolved biotite mineral in a plug flow reactor at controlled pH and T = 25 °C, and synthesized TO- and TOT-phyllosilicates (lizardite and kerolite, respectively) at T = 90 - 250 °C. All leaching solutions during biotite dissolution are enriched in light isotopes compared to the biotite sample, with a 1.1‰ range of $\Delta^{26}Mg_{biotite-solution}$. At pH = 1, Mg isotopic steady-state between the solution and biotite is established after 600 h, while at pH = 5, it is never reached, even after 4 month. A sequential leaching suggests that the solution δ^{26}Mg values reflect a mixing between labile Mg and structural Mg with different δ^{26}Mg values. During synthetic clay formation, both TO and TOT clays are significantly enriched in heavy isotopes and follow Rayleigh fractionation equations for specific values of isotope fractionation factors. At T = 250 °C, a single isotope fractionation factor of 1.00059 ± 0.00014 can explain the Mg isotope evolution of both TO and TOT clays. A similar isotope fractionation factor of 1.00054 ± 0.00014 can be inferred from all TOT synthesized at T = 90 - 250 °C. A compilation of Mg isotope fractionation factors during secondary phase formation highlights a difference between field and experimental investigations at low temperature. More experiments are now necessary to determine the role of clay crystallochemistry at $T < 50$ °C.