A worldwide survey of Li and Mg isotopes in river clays

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Establishing control laws for silicate weathering at the global scale still remains challenging, mostly because of intertwined effects of various parameters such as lithology, topography, climate, vegetation and land use. Investigations of silicate weathering are generally conducted at the scale of small well-constrained monolithological watersheds, or in large river basins, such as the Amazon or the Ganges. An alternative - more global - approach consists in acquiring weathering proxy data for clay- and silt-size fractions of sediments deposited by rivers worldwide. Using this approach, Bayon et al. (2016, 2018) have recently demonstrated that the distribution of Hf–Nd and Si isotopes in river clays was – at present - mostly controlled by silicate weathering intensity and climate. Following these studies, here we report Li and Mg isotopic compositions for the same set of river sediment samples. In the literature, both isotope systems have been shown to be strongly related to silicate weathering intensity in monolithological areas, but also by lithology when measured for large river basins.

At the global scale, we find that clays are significantly enriched in Li and Mg compared to rocks and silts, on average by a factor of 2.4 and 1.6, respectively. This confirms that these elements are not easily mobilised during continental alteration, and they are preferentially incorporated into secondary phases during the neoformation process. Clay Li isotope compositions vary widely (from -5‰ to +4‰) while their Mg isotope compositions remain within a narrow range (-0.4‰ to + 0.2 ‰), in agreement with their respective ability to fractionate. The average values for Li and Mg isotopes in silts are similar to the ones previously published for the Upper Continental Crust.

In contrast with Hf–Nd and Si isotopes, the distribution of Li-Mg isotopes in river clays do not display any simple link with climate. Soil formation rates that strongly influence Li and Mg isotope fractionation during weathering could explain this discrepancy. A simple modeling also including published data for rocks and waters suggests that we can use our dataset to estimate if soils are in steady-state at the world-scale. More investigations are now required to refine this modeling and better define the impact of recent climate change and anthropogenic activities on soil thickness at the global scale.