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Does cation loading prompt clay formation in watersheds?

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Enhanced weathering (EW) is a form of carbon dioxide removal (CDR) that has the potential to provide long term, durable removals while increasing crop yields and improving soil health through deacidification. However, there are still major gaps in our understanding of the efficacy of this process. If EW is going to be implemented at scale to drive CDR we need to be able to estimate long-term fate of the weathering products. Initial CO_2 removal occurs in soils during weathering—when the reaction of dissolved carbon dioxide and cation-rich rocks produces dissolved cations (Ca^{2+}, Mg^{2+}, Na^{1+}) and bicarbonate (HCO^{3-}). In the idealized case, the weathering products move from soils to groundwaters, to rivers, and eventually to the oceans. If the cations are removed during clay formation before making their way to the ocean the initial carbon removal is reversed. Clay formation rates will be highest in the uppermost portion of the soil column, where they can be directly tracked through empirical observations. Clay formation may, however, also occur when waters are percolating through the soil column. There are currently few constraints on the extent to which process will undo the effects of initial weathering. Here we present a high-resolution lithium isotope data set from rivers that we use to constrain variability in clay formation within the soil column. We find no evidence for increased clay formation with higher cation fluxes through the soil column. These results support the viability of EW as a form of CDR and this approach provides a means to track where clay formation from groundwaters can prohibit effective implementation of enhanced weathering.