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Reactive transport modelling reveals changes in properties of tropical soils subjected to enhanced silicate weathering

Juliette Glorieux et al.

Applied regionally to cropland soils, enhanced silicate weathering (ESW) is advocated as a viable technology for enhancing the consumption of atmospheric CO_2, while also providing ancillary benefits to soil fertility and crop growth. However, important uncertainties remain regarding the short- and long-term effects of silicate addition on weathering rate and soil properties. To address this issue, we adapted and used the reactive transport model WITCH[1] to simulate weathering in a tropical soil (Oxisol) amended annually with 50 t ha^{-1} of crushed basalt over five years. We monitored the changes in the soil chemical properties, primary and secondary mineralogy and CO_2 consumption rate over a 10-year period. The modelling results confirm that the instantaneous CO_2 consumption rate increases with basalt application. Basalt weathering increases the pH of the soil solution, from acidic to alkaline values, and releases Ca, Mg and K in solution, thus serving as a plant nutrient source. We also found that allophanes may form in the Oxisol in response to dissolution of the basalt's glass and plagioclases. As evidenced in volcanic soils, allophanes typically exhibit a significant potential for organic carbon stabilisation. The formation of allophanes in the Oxisol treated with basalt may improve aggregation processes, water retention and hydraulic conductivity, but may decrease phosphate availability further. Our modelling study highlights that the intentional application of basalt to a tropical soil affects various soil properties significantly. The short and long-term impacts of these changes on soil functioning will need to be assessed.

[1]Goddéris et al., 2006. GCA 70:1128-1147

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