Reactive transport modeling the oxalate-carbonate pathway of the Iroko tree

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Biologically facilitated calcite formation through the oxalate-carbonate pathway (OCP) of the Iroko tree (*Milicia exselsa*) has been previously studied as a method of natural carbon capture. Previous field and lab work suggests that the OCP functions though biomineralization; calcium-oxalate originating from fallen plant tissue is oxidized by oxalotrophic bacteria, resulting in the alkalization of local tropical soil, so that calcite may precipitate. A reactive transport (RT) model of the Iroko Tree OCP was constructed to examine and quantify these processes.

The RT model focused on quantitatively evaluating the fluxes and fate of calcium and carbon in the different components of the OCP process, to assess how much carbon could be stored as calcite in soils around the Iroko tree over and beyond its life cycle. Calcium input from dust, precipitation, bedrock weathering, and plant nutrient cycling, was combined with precipitation and transpiration rates, litter fall, decomposition and nutrient return.

A plot-scale model representing a vertical soil profile was constructed using the RT code MIN3P-THCm and the parameters described. Preliminary model results indicate that, given sufficient oxalate influx over time, soil pH rises from an initial acidic value (soil pH = 5.1) to more alkaline (soil pH = 7-9). Even without considering precipitation of calcite, the increase of alkalinity leads to CO_2 sequestration within the soil. Modeling results indicate that if sufficient Ca^{2+} is present, calcite precipitation occurs where calcium oxalate is present (near the surface), but does not occur where Ca^{2+} is limited, with implications for longer-term carbon sequestration processes.

Additional models are being constructed to assess the spatial extent and influence of the pH change, to be coupled with a root architecture model to investigate the overall role of the root system on biomineralization and the OCP of the Iroko tree.