2-D reactive transport modeling of biogeochemical carbon sequestration by the Iroko tree - Examination of spatial dependencies of the oxalate carbonate pathway

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The biologically facilitated formation of calcite via the oxalate-carbonate pathway (OCP) of the Iroko tree (*Milicia exselsa*) has been studied as a method of natural carbon capture. Field and lab work suggest that calcium-oxalate originating from fallen plant tissue is oxidized by oxalotrophic bacteria, causing the local soil pH to increase, and permitting the precipitation of calcite in an acidic tropical soil previously devoid of any carbonate minerals.

Reactive transport (RT) modeling of the Iroko OCP at the plot scale has indicated that the biogeochemical pathway of the OCP does indeed follow previously suggested mechanisms. A sensitivity analysis focusing on the mass balance for Ca suggests that carbonate mineral formation can be facilitated by a variety of different scenarios on the magnitude observed in the field. Preliminary modeling results also revealed that spatial distribution of roots in both the lateral and vertical direction, extent of the foliar crown, and changing accessibility of roots to more (or less) Ca, all play important roles in determining the magnitude, distribution, and timing of both the soil pH change, and calcite precipitation.

In order to consider the relationship between Ca availability in soil and the lateral root distribution that preliminary modeling has shown to be integral to the OCP mechanism, a 2-D model of the Iroko system was constructed using the RT code MIN3P-THCm, representing both a vertical soil column and lateral root extent. The 2-D model focuses on the relationship between changing lateral root distribution through time, Ca accumulation by the tree, and Ca-oxalate loss from the tree through time, in order to assess the geochemical evolution and gradient of the soil pH change, as well as the possible spatial distribution of calcite precipitation in the surrounding soil.