Geophysical Research Abstracts, Vol. 9, 03050, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03050

Mineralogical and biogeochemical record of weathering in tropical soils: the unusual oxalate-carbonate pathway

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Biologically induced accumulations of calcium carbonate have been found inside orthox soils, under and around the native iroko tree *Milicia excelsa* (Moraceae) in Ivory Coast, Cameroon, Burkina Faso. The nature of these accumulations and their origin were studied in two soil profiles from Ivory coast, directly under the tree and at a distance of 30 cm from the trunk. Microscale forms of $CaCO_3$ include: (1) wood pseudomorphic structures such as parenchyma cells, cellulose fibers, and calcitic vessel infillings; (2) three types of rhombohedra; and (3) needle fiber calcite. In addition, large scale blocks exhibit three types of textures: (1) micritic calcite, which seems to be the original material; (2) light-colored sparite in moldic voids; and (3) asymmetrical radiaxial laminated fibrous cement. Some micritic aggregates and hemi-spherulites (vaterite) were found in the sap on the trunk as well as in soils on silica grains and the wood itself. The mineralogy of all these carbonate forms is mainly a stœchiometric calcite or a moderately-enriched Mg calcite. But some samples contain monohydrocalcite, as well as two polymorphs of calcium oxalate (weddellite and whewellite). Calcite precipitation is facilitated by the oxidation of oxalate by soil bacteria that contributes to the increase in pH in soils. This is in contrast to conventional orthox soils behaviour. Therefore, three conditions are necessary for biologically induced precipitation of calcium carbonate in orthox soils associated with iroko trees: the presence of a large amount of oxalate (originating from the tree and fungi), the existence of an oxalotrophic bacteria for oxalate oxidation into carbonate, and a dry season. A biogeochemical model is proposed to explain the shift in pH in relationship to the pCO_2 and the oxalotrophic activity, demonstrating the existence of a potential carbon sink.