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Solid phase stability in a Brazilian Ferralsol: column experiment and modelling

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Ferralsols are highly weathered soils characteristic of the moist tropics. Many Ferralsols have kaolinitic horizons overlying more gibbsitic ones (Lucas, 1989), for which there has been no satisfactory pedological explanation. Lucas et al. (1993) and Rose et al. (1993) found that the forest recycles significant quantities of chemical elements, particularly Si and Al, and suggested that the stability of the kaolinite in the upper part of the profile was caused by this. To understand the processes Cornu et al. (1998) determined an annual balance of the transfer of dissolved Si, Fe and Al by rain, throughfall, stemflow, soil water and groundwater runoff in an Amazonian Ferralsol. They concluded that the inputs of dissolved Fe, Al and Si to the topsoil were small but not negligible and that the balances of the elements in the upper soil horizons have to take into account translocation of dissolved elements in the slowly percolating water. In order to achieve this we build up a soil column experiment considering suction at the column base in order to collect the slow percolating waters. This experiment was coupled with thermodynamic modelling of soil solution extracts. To better understand transformations throughout soil horizons, we set columns containing i) A horizon only; ii) A over B horizon; and, iii) A over B over C horizons. Such columns were submitted to two cycles of water percolation: one simulating a rainy season and another simulating a dry season. Soil mineralogy was identified by combining XRD, DTA/DTGA and normative calculations derived from total soil analyses. Soil solution was analysed with respect to pH and EC as well as major solutes (Al, Ca, K, Fe, Mg, Mn, Na, nitrate, sulphate, chloride, Si, and DOC) for modelling purposes with Visual

Minteq (version 2.53; Gustafsson, 2007). Results evidenced the presence of kaolinite as the main constituent of the clay fraction whereas quartz was the major component of the 0-2 mm soil fraction. Illite and gibbsite were found in increasing contents toward subsurface horizons, while hydroxyinterlayered vermiculite contents increased towards surface horizons. With respect to modelling, we emphasized the importance of developing a database for mineral formation/dissolution as well as for description of stability lines for HIV and illite under conditions of Brazilian soils, as this is of primary importance for modelling purposes. We also underlined the importance of Al-DOM complexation as it takes a role in Al activity in solution, which in turns may or may not allow the formation of the different solid phases. The thermodynamic modelling used in this study provided a realistically approach on the stability of illite, HIV, kaolinite, and gibbsite in this Ferralsol.

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