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Differential weathering and chemical denudation on tropical toposequences constrain P availability and forest characteristics in nutrient-poor Amazonian soils (French Guiana)

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In the Guiana craton, large areas of tropical forest have grown and evolved over an undulant topography, result of thousand to million years of hydromorphic weathering. The effects of the resultant relief (mesotopography) on soil properties and nutrient cycling are studied using a multidisciplinary approach in Paracou and Nouragues (French Guiana). Soil texture, mineralogy, stoichiometry, chemical composition, and enzymatic activities and variables of forest structure have been measured in several plots along short topographic gradients (ca. 50-80 m drop), in top, slope and bottom positions. Despite sharing the same mafic bedrock, large differences on soil mineralogy are found on the weathering mantle of each study site, between the plots located on top positions (acrisols) and bottom areas (podzols). The soils on the top are very acidic, fine-sized soils, dominated by kaolinite, with elevated concentrations of iron (Fe) and aluminum (Al) oxides. The soils at the bottom are sandy and present an important quartz fraction with a lower amount of clay minerals. As a result, mottled chemical features -including soil phosphorus (P) cycling patterns-, characterize this landscape. The diffusion of soluble P forms is facilitated in bottom soils, due to the proximity of the water table and the coarser texture. However, top plots soils contain higher values of total P, but lower available P forms, due to adsorption on the fine sized highly reactive oxides. This mechanism for P occlusion obliges a higher investment of microbial and root activity in P acquisition. Acid and alkaline phosphatase activities – and probably also rhizosphere exudates- are higher on top sites, strongly correlating with Fe concentration. Forest characteristics differ among plots along the mesotopographic gradient: higher wood density towards the top plots, but faster growth rate, tree size and turnover rate towards the bottom plots. The described nutrient and hydric patterns may have partially controlled ecosystem-level adaptations to gentle topographic gradients, as a source of niche differentiation at short distances inducing distinct carbon storage capacity and differential responses to anthropogenic environmental changes.