The chronosequence in context: Elevation-dependent dynamics of soil biogeochemistry during cloud forest succession

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In mountainous landscapes, rates of soil morphological and biogeochemical change during secondary forest succession (SFS) can vary widely with elevation due to gradients in water, energy, and mineral weathering status. Improved understanding of how elevation mediates the response of soils to SFS is critical not only for reducing the uncertainty of soil maps in complex terrain, but also for predicting the edaphic effects of SFS under future climatic conditions. Focusing on volcanic ash soils in Veracruz, Mexico, we sought to 1) quantify how elevation mediates the dynamics of soil organic carbon (SOC) and geochemistry during SFS and 2) disentangle the soil-forming processes responsible for altitudinal trends. We characterized 16 soil profiles (0-100 cm depth) at various stages of SFS after pasture abandonment at the lower and upper altitudinal limits of the cloud forest ecosystem (1350-1550 and 2050-2220 m) using a broad suite of analytical techniques. Elevation strongly affected the depth distributions of all measured inorganic elements and enhanced the rate of accumulation of biocycled elements (e.g., P, K, Ca, S, Mn) during SFS. Notwithstanding altitudinal differences in C inputs (namely, forest floor recovery rates), profile-level SOC composition and dynamics were more sensitive to mineral weathering status than to SFS stage or elevation per se. Differentiation of soil mineralogy and SOC dynamics contributed to variation of physical properties, consistent with local ‘folk’ soil taxonomy. Ongoing work addresses the interplay of climate, geology, and redistribution processes in determining the mineralogical properties and, ultimately, SOC dynamics of volcanic ash soils. Our findings underscore the importance of considering the complex environmental contingency of soil recovery rates during SFS.