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Soil processes and Si biocycling interplays: implications in tropical ecosystems

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The primary source of dissolved Si (DSi) in terrestrial ecosystems is the pool of lithogenic silicates (LSi). DSi may be leached out towards the hydrosystem, involved in the formation of pedogenic clay minerals (PSi), adsorbed on Al and Fe oxides, or taken up by plants wherein it forms phytoliths (PhSi). Dissolution of LSi, formation of PSi, and Si adsorption on oxides define a mineral Si feedback loop. Si plant uptake, phytolith formation, return and dissolution in soil define a biological Si feedback loop. Both loops interact through soil processes and Si biocycling. Here, we discuss the interdependent relationship between soil processes and the return of PhSi in soils, and their controls on the biological Si feedback loop, with a special focus on highly desilicated tropical soils.
Plants play a crucial role in soil evolution by promoting weathering, and forming phytoliths. They thus act as Si sinks and sources in soils. With increasing weathering, i.e. depletion of LSi and PSi minerals, the biological Si feedback loop progressively takes over the mineral Si feedback loop. Indeed, the soil becomes increasingly concentrated in PhSi (phytogenic amorphous silicates), which are constantly formed in plant and dissolved in soil. Paradoxically, the Si biocycling is thus more intense in soils depleted in primary LSi source. By converting soil LSi and PSi into PhSi, plants increase the mobility of Si in soil: they further alleviate desilication in the topsoil.
Non-essential plant Si is thus an essential link between mineral and living worlds. The dynamics of Si in terrestrial ecosystems is indeed largely governed by pedogenesis and its relationship with plant community and diversity. Consequently, the appraisal of soil constituents and processes is central to further understand their interaction with the biological Si feedback loop, especially in highly leached tropical soils where the reserve of Si-bearing minerals is largely depleted.