

Controls on lignin degradation in a temperate deciduous forest

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Degradation of lignin might play a critical role for carbon (C) storage in soils. Changes in climate or land-use affect inputs of nitrogen (N) and dissolved organic matter (DOM) to topsoils. We studied possible consequences for lignin degradation at a beech–oak site in Southern Germany. We hypothesized that degradation of lignin and other recalcitrant organic matter (OM) decreases with N inputs, but increases with input of easily degradable OM. The study also addressed effects of DOM composition on lignin degradation.

A column experiment using A horizon samples was conducted. Solutions differing in N and of different concentrations of DOM of various composition (i.e. glucose, DOM extracts of fresh or humified litter material) were added every 2–4 weeks for 11 months. Total N additions ranged from 0–32 mg N g⁻¹ soil-N, organic C additions were 0 or 11 mg C g⁻¹ soil-C (i.e. maximum C and N added equaled 2–3 times the annual input of dissolved organic C and total N from forest floors). Lignin degradation was assessed after 5 and 11 months using the CuO oxidation method.

In controls (no N or DOM added), the cumulated CO₂-C evolution (during 11 months of incubation) amounted to 13% of initial soil-C, while CO₂-evolution diminished during incubation indicating decreased C availability. Yields of lignin phenols decreased by 19% (0–11 months). Even in the later period (5–11 months), lignin degradation proceeded, suggesting it was not limited by easily degradable OM. In line, glucose addition increased CO₂ evolution from soil-OM, but lignin degradation was not affected. However, addition of DOM led to enhanced lignin oxidation after 11 incubation months but the composition of DOM had no effect. This suggests that lignin degraders were stimulated by input of a complex mixture of organic compounds, but against expectations the share of easily degradable compounds played no role. Also N input did not affect CO₂ evolution or lignin degradation. To conclude, altered N inputs to topsoils due to land-use or climate change will not affect lignin degradation, whereas altered DOM inputs presumably has an effect. However, altered C availability seems not to be the reason. Other possible mechanisms will be discussed.

Basanite-phonolite mixing indicated by trace elements in green-core clinopyroxenes from La Palma

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Green-core clinopyroxenes (Cpx) are ubiquitous in alkalic basalts worldwide. Commonly, anhedral and rounded green cores are enriched in Na, Fe and Mn compared to brownish rims and groundmass Cpx. Most are believed to have been formed by crystallization in evolved melts followed by magma mixing prior to eruption [1, 2].

This interpretation was tested by trace element analyses of Cpx phenocrysts in lavas from the active Cumbre Vieja volcano on La Palma (Canary Islands) where basanites and tephrites contain abundant green-core Cpx. Zoned and unzoned greenish Cpx in phonolites show a wide compositional range and characteristic S-shaped REE spectra with (La/Nd)_N > 1, (La/Lu)_N > 1 and (Tm/Lu)_N ≤ 1. The spectra strongly differ from those of brownish Cpx rims and Cpx phenocrysts in basanites to tephrites, that have (La/Nd)_N < 1 and (Tm/Lu)_N > 1. The latter are also more restricted in composition and have higher compatible and lower incompatible trace element contents, and lower Zr/Hf and Nb/Ta, than phonolite-hosted Cpx. Calculated REE spectra of corresponding melts show strong enrichment of light relative to heavy REE, and are straight for basanites to tephrites but concave-upward for phonolites. All these differences are consistent with fractionation of observed phenocryst phases during the formation of phonolithic melts, with titanite being responsible for Nb/Ta fractionation.

Trace-element compositions of rounded cores from green-core Cpx overlap completely with green Cpx in phonolites, but differ systematically from brownish Cpx. This provides unequivocal evidence for formation of green-core Cpx in phonolithic melts, resorption after mixing with more primitive melt, and subsequent overgrowth by brownish Cpx. Mixing most likely occurs in the uppermost mantle at 430–780 MPa where La Palma magmas fractionate prior to eruption [3]. The commonness of green-core Cpx shows that mixing between basanitic and phonolithic melts periodically occurs beneath La Palma and is important to the evolution of magmas. The data also suggest that much more phonolite is produced at depth than inferred from erupted lavas.

[1] Brooks & Prinzlau (1978) *JVGR* **4**, 315–331. [2] Duda & Schmincke (1985) *CMP* **91**, 340–353. [3] Klügel *et al.* (2005) *EPSL* **236**, 211–226.