

Deep subsoil tree phosphorus sources in forest ecosystems

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As forest ecosystems evolve over pedogenic timescales chemical weathering alters the nutrient status of the regolith. To maintain the nutrient status to a vital level plants developed strategies such as nutrient uplift and recycling [1]. Since phosphorus (P) is a plant-limiting element it is predestined to explore from what depth forest ecosystems obtain their P in a supply-limited (meaning element-depleted) weathering regime.

Therefore, we selected two study sites with contrasting parent bedrock P concentrations in the Black Forest and in the Bavarian Forest. Both study sites are underlain by gneissic bedrock, mantled by Cambisols and covered by a mixed deciduous and coniferous forest. At both study sites we drilled up to 30m deep drilling cores through the regolith into unweathered bedrock and applied geochemical mass balances to characterise the nutrient status of the regolith. While the depletion of soluble nutrients (Ca, Mg, K) is high in the Black Forest (supply-limited) soluble nutrients are only partially lost in the Bavarian Forest (kinetically-limited).

In spite of these differences in the weathering regime P is depleted by up to 70% relative to bedrock at both study sites. Between topsoil and 3m depth the remaining 30% are mainly converted into bio-inaccessible P forms. Therefore, we hypothesize that nutrients are assimilated by plants from remaining primary minerals such as apatite and silicates below 3m depth down to the weathering front located at 7m depth in the Black Forest.

Using isotope geochemical tools such as traditional ⁸⁷Sr/⁸⁶Sr and innovative meteoric ¹⁰Be/⁹Be source tracer we find that mineral-derived nutrients are taken up from surprisingly deep layers at 3-7m at both study sites. This challenges the view that mineral-derived nutrients are taken up from shallow soil horizons. However, re-enrichment of micro-nutrients in the shallow soil as shown by mass transfer coefficients provide indications that these nutrients are recycled and become available in organic-bound sources in the Black Forest. Because in the Black Forest nutrients are simultaneously mineral-derived from 3-7m depth and also organic-derived from shallow soil, we suggest that the so called nutrient-pump [1] is active.

[1] Jobbagy and Jackson (2001) Biogeochem., **53**, p.51-77