Phosphorus dynamics on temperate forest soils: a dual isotopes approach

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Introduction and Methods

Phosphorus (P) is an essential nutrient for living organisms. Due to its very low concentration in the soil solution, it is often limiting for plants. P in the soil solution is replenished by the release from sorbed phases, the dissolution of P containing minerals and by the enzymatic hydrolysis of organic P compounds (P mineralization). However the relative contribution of all these processes in soils is mostly unknown.

Radio- and sable isotopes provide direct insight into processes phosphate goes through at the ecosystem level. Within the German Priority Program "Ecosystem Nutrition: Forest Strategies for limited Phosphorus Resources", we studied P dynamics in organic horizons (Of/Oh) from two contrasting soils (low- and high-P availability) under beech forests. Our hypothesis was that under low P availability conditions the replenishment of P in solution is mostly controlled by the mineralization and immobilization driven by P demand of microbes. On a three-months incubation, we double labelled the soil with ^{18}O-enriched water and ^{33}P. The incorporation of ^{18}O from water into phosphate is a proxy for biological P transformation via enzymatic hydrolysis or intracellular P turnover.

Results and Discussion

Estimated P fluxes from gross and net mineralization rate and abiotic exchanges (sorption/desorption onto solid phases) showed a clear dominance of biological processes under low P availability. Gross mineralization indeed acconted for up to 90% of P fluxes to the soil solution. Whereas we observed the opposite under high P availability.

The incorporation of ^{18}O into phosphate showed that different enzymatic processes were dominant in the two contrasting soils, with enzymatic hydrolysis via phosphatases being prevalent under low phosphorus conditions.

These results support the hypothesis that organic P has a faster turnover under low P availability. Net mineralization is therefore the most relevant process providing available P for plants under these conditions.