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Phosphorus (P) availability and P transformation rates in Amazonian Dark Earth determined by ^{33}P isotopic dilution

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Amazonian Dark Earth (ADE) often shows increased soil fertility compared to surrounding soils, likely linked to its increased concentration of soil organic matter and macronutrients such as phosphorus (P). For P, there is little knowledge whether the higher P availability is a result of increased biological processes (such as organic P mineralization) or physico-chemical processes (such as sorption/desorption), or both. Using the ^{33}P isotopic dilution approach we aimed to quantify the exchangeability of inorganic P as well as organic P mineralization rates of ADE under secondary forest and a cassava plantation.

For that, ^{33}P labelled ADE as well as surrounding soil (highly weathered, no "dark earth" features) under both land use systems (forest and cassava) were incubated for a period of 14 days. P-concentrations and specific activity of the added ^{33}P tracer were determined on four time points in the water-extractable P pool as well as in the microbial P pool (resin-fumigation method).

ADE showed generally increased concentrations of total P and loosely bound P (water extractable P; resin extractable P) compared to surrounding soils. Isotopically exchangeable P was similar in both analyzed ADEs (approx. 150 mg kg^{-1} soil after 7 days), yet significantly higher compared to surrounding soils (30 to 90 mg kg^{-1} soil after 7 days). A numerical model used to estimate P transformation rates suggests the dominance of physico-chemical processes over biological processes in ADE under both land use systems. However, biological processes were at least doubled in ADE, compared to surrounding soils.

We conclude that the higher P availability in ADE is largely caused by increases in the exchangeable inorganic P pool. While biological processes (mineralization/microbial immobilization) were increased in ADE compared to surrounding soils, their net effect on P availability remains small. In a next step, organic P in ADE will be characterized in alkaline soil extracts using ^{31}P NMR spectroscopy to increase the understanding which forms of P are included in the build-up of organic P in ADE soils.