Geophysical Research Abstracts
Vol. 17, EGU2015-11740-1, 2015
EGU General Assembly 2015

Soil phosphorus mobility and solid-to-solution phase resupply studied by diffusive gradients in thin films: background soil properties driving their variation

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The mobility and resupply of inorganic phosphorus (P) from the solid phase was studied in 32 representative soils from the UK. The objective was to identify the background soil properties driving the variation of soil inorganic P desorption kinetics across different soil types. Diffusive gradients in thin films (DGT), diffusive equilibration in thin films (DET) and the DGT-induced fluxes in sediments model (DIFS) were used as tools for exploring solid-to-solution desorption kinetics. Previously characterized physicochemical properties of the same soils were used for correlation analysis. On average and across soil types, the inorganic P maximum distance of depletion was 0.42 ± 0.10 cm, the equilibration time (Tc) was 3.63 h, the desorption rate constant (k-1) was 0.0046 h-1, and the desorption rate was 4.71 nmol l-1 s-1. The correlation between P in Olsen extractcs (POlsen) with PDGT, PDET and phosphorus effective concentration (PE) was enhanced when similar soils were isolated and used in the comparison, clearly showing that these parameters are affected differently by soil types. The PE was better correlated to Ptot, POlsen, PFeO, and PNaOH/EDTA than PDGT. This may indicate that PE is a better representation of P availability across soil types than PDGT. While the relative DGT-induced inorganic P flux in the first hour is mainly a function of soil wetting properties and % Corg, at longer times it is a function of the resupply capacity (R-Rdiff) of the soil solid phase. In general, resupply of P from the solid phase was less than that for other chemical elements, as shown by high Tc and low k-1 values. Desorption rates and resupply from the solid phase were fundamentally influenced by P saturation status, as reflected by their strong correlation with P concentration in water, FeO strips, Olsen and NaOH-EDTA extracts. Soil pH and particle size distribution had little or no effect on the evaluated parameters. The DGT and DET techniques, along with the DIFS model, were considered accurate and practical tools for studying parameters related to soil P desorption kinetics and are thus likely to be useful for estimating the ability of soil to supply P for biological requirement.