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Schicksal, Wechselwirkungen und Wirkung von bodenfremden Stoffen im Boden

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Titel
Cadmium, copper and zinc stable isotopes as analytical tool to trace sources and processes in agricultural systems

Abstract
In agriculture, mineral phosphate (P) fertilizer application leads to an unintended input of Cadmium (Cd) into agricultural systems. Cd is highly toxic and its incorporation into the food chain endangers human health. Copper (Cu) and zinc (Zn) are used as feed additives and pharmaceuticals and can accumulate with farmyard manure in agricultural soils. Although being micronutrients, high Cu and Zn concentrations are toxic. Former studies revealed Cd, Cu and Zn accumulations in Swiss agricultural soils in the past decades. However, these studies were not completely based on in-situ measured data. The aim of this study was to fill this gap and measure Cd, Cu and Zn fluxes at selected Swiss agricultural sites. Specifically, we aimed to trace the metals in the soil and to differentiate between anthropogenic and geogenic sources. Additionally, we further elucidated metal redistribution in Swiss agricultural systems, based on the measurements of stable metal isotope ratios of different system pools. For that purpose, metal balances of three arable (Cd) and three grassland (Cu & Zn) sites were determined by measuring the soil metal concentrations and all inputs (bulk deposition, mineral P fertilizers, manure & parent material) and outputs (seepage water, crop & grass harvest) during one hydrological year (May 2014 – May 2015). Furthermore, stable metal isotopes of the soil and all inputs and outputs were (Cd) and will be (Cu & Zn) determined. Cd mass balances showed losses for wheat cultivation (-0.01 to -0.35 g ha^{-1} y^{-1}) and accumulations for barley cultivation (0.18 to 0.71 g ha^{-1} y^{-1}). Isotopic ratios in wheat (?$^{114/110}Cd_{straw-grain}$= -0.34 to -0.38‰) and barley plants (-0.44 to -0.82‰) revealed that uptake and retranslocation of Cd in the plants is driven by physiological processes to reduce toxic Cd impacts. Cu and Zn mass balances showed that manure application is by far the most important Cu (146-340 g ha^{-1} y^{-1}) and Zn (947-1’742 g ha $^{-1}$ y^{-1}) input. Inputs with bulk deposition and through parent material weathering were by 1-2 orders of magnitude smaller. Beside the Cu and Zn budgets, stable isotope data (not yet analysed) will be presented and discussed to assess the biogeochemical processes and redistribution of (anthropogenic) Cu and Zn in agricultural systems.