Cadmium mass and stable isotope budget of three Swiss wheat cropping sites

M. IMSENG*[1], M. BIGALKE[1], M. WIGGENHAUSER[2], E. FROSSARD[2], M. MÜLLER[3], A. KELLER[3], M. REHKÄMPER[4], K. KREISSIG[4], K. MURPHY[4], W. WILCKE[5]

[1]Geographic Institute, University of Bern, Hallerstrasse 12, CH-3012 Bern (*corresp.: martin.imseng@giub.unibe.ch, moritz.bigalke@giub.unibe.ch)

[2]Institut für Agrarwissenschaften, ETHZ, Eschikon 33, CH-8315 Lindau (matthias.wiggenhauser@usys.ethz.ch, emmanuel.frossard@usys.ethz.ch)

[3]Agroscope, Reckenholzstrasse 191, CH-8046 Zürich (michael.mueller@agroscope.admin.ch, armin.keller@agroscope.admin.ch)

[4]Department of Earth Science & Engineering, Imperial College, London SW7 2AZ, UK (markrehk@imperial.ac.uk, k.kreissig@imperial.ac.uk, k.murphy12@imperial.ac.uk)

[5]Institut für Geographie und Geoökologie, KIT, Kaiserstr. 12, D-76131 Karlsruhe (wolfgang.wilcke@kit.edu)

Mineral phosphate fertilizers contain up to 600 mg Cd kg^{1} P and its application might result in Cd accumulation in the fertilized soils. Cd incorporation into the food chain might finally affect human health. We sampled soil in different depths and all inputs and outputs of three wheat cropping sites for one hydrological year. The Cd concentrations and stable isotope ratios of soils, soil parent material, mineral phosphate fertilizers, bulk deposition, wheat plants (roots, straw and grains) and soil water were analyzed. After matrix separation, Cd isotope compositions were determined by double-spike MC-ICPMS. The main Cd input was via mineral phosphate fertilizers, the main output was with the harvest. Inputs exceeded outputs so that Cd accumulated in the soils. The soils showed no vertical variations in $\delta^{114/110}$Cd values. Only one soil, originating from limestone, was fractionated compared to the parent material with $\Delta^{114/110}Cd_{parent-soil}$ = 0.27‰. The main inputs from mineral phosphate fertilizers ($\delta^{114/110}$Cd = 0.13 to 0.26‰) and precipitation (-0.15 to 0.15‰) showed limited variation in Cd isotope ratios. In contrast, the main outputs to wheat harvest (0.43 to 0.78‰) and seepage water (0.39 to 0.79‰) showed positive fractionation. The bedrock-soil, soil-soil solution and soil-plant induced isotope fractionation are discussed to investigate biogeochemical processes of Cd in terrestrial systems. Cd isotope budgets are used for source tracing to improve the understanding of Cd fluxes in agricultural systems.