# Combined cadmium stable isotope and solid state speciation measurements in contaminated soil-rice systems

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Staple crops such as rice are our major sources of cadmium (Cd). Therefore, a fundamental understanding of processes that control Cd accumulation in crops is crucial. Currently, we investigate major mechanisms that determine the Cd transfer from soil to plant in contaminated soil-rice systems by combining synchrotron solid state speciation analysis with Cd stable isotope process tracing.

We grew rice (*Oryza sativa* L.) in pots that contained wet and flooded soils that were spiked with 15 mg Cd $[\text{kg soil}]^{-1}$ and harvested the plants at flowering stage. We cultivated two rice accessions which have functional and non-functional vacuolar Cd transporter to retain Cd in roots. During plant growth, we frequently collected soil solution and analyzed pH, Eh, TOC, major cations and anions, Fe, Zn, and Cd concentrations to model Cd speciation in soil solution. For analysis of stable Cd isotope ratios, samples were purified and measured using MC-ICPMS. For bulk XANES analysis, samples were frozen with liquid nitrogen immediately after their harvest.

Preliminary results show that Cd transfer from soil to rice (whole plant) was higher in the wet (1940-2552 µg $[\text{kg soil}]^{-1}$) compared to the flooded soil (917-1000 µg $[\text{kg soil}]^{-1}$) which we ascribe to soil pH that rose from 5.2 to 6.1 induced by changing redox conditions. The rice accessions with functional Cd root vacuolar transporter accumulated 5.1 to 7.4 times more Cd in roots than in shoots and retained light Cd isotopes in the roots ($\Delta^{114/110}Cd_{shoot\text{-}root}$ = 0.15 to 0.16 ‰). In contrast, the rice without functional vacuolar Cd transporter accumulated 1.4 to 2.9 times more Cd in shoots than in roots while less or no isotope fractionation occurred between shoot and root (-0.01 to 0.10 ‰). We ascribe the retention of light Cd isotopes in the root vacuoles to Cd complexation to thiols. At the conference, solid state speciation measurements will be presented to test this hypothesis. Furthermore, soil solution speciation modelling will be added to the data set and we will present refined conceptual models of Cd isotope fractionation in soil-plant systems.