Tracing Se speciation in a biogeochmical model from mineral adsorption to plant partitioning

A. K. NOTHSTEIN*[1], E. EICHE[1], M. RIEMANN[2], P. NICK[2] AND T. NEUMANN[1]

[1]Institute of Mineralogy and Geochemistry (IMG), Karlsruhe Institute of Technology (KIT), Adenauerring 20b, D-76131 Karlsruhe, Germany

[2]Molecular Cell Biology, Botanical Institute, and Center for Functional Nanostructures (CFN), Karlsruhe, Institute of Technology (KIT), Kaiserstraße 2, D-76131 Karlsruhe, Germany

*correspondence: a.nothstein@kit.edu

Biofortification of Se-deficient crops is still little understood in detail regarding biomolecular and geochemical interactions.

In a biogeochemical model, we incorporated three compartments of the Critical Zone (soil minerals, nutrient solution and plants) to determine species-dependent Se transfer. Adsorption-desorption processes of selenate and selenite onto kaolinite and goethite in the presence of nutrients was coupled with plant Se uptake and partitioning depending on the available Se species. Closed plant-box systems with *Oryza sativa* caryopses were prepared with Se-spiked nutrient solution of 0 - 10000 μg/L Se as selenite or selenate and a sorbing mineral phase of either kaolinite or goethite. Plant-less sorption controls were prepared in glass bottles parallel to the plant-box experiments.

ICP-MS measurements of remaining Se solution concentrations showed that selenite affinity for kaolinite and goethite was 61 and 99 %, respectively, and selenate's affinity for kaolinite and goethite was 72 and 42 %, respectively. Desorption yielded 71 - 96 % of previously adsorbed Se exchangeable by ion exchange with phosphate even when adsorbed to goethite as selenite. However, subsequent plant Se-uptake was not higher through contact with the mineral than as it was in just the nutrient solution.

Se taken up as selenate was distributed mainly to the shoots (62 - 78 %), Se taken up as selenite was distributed mainly to the roots (66 - 80 %), as revealed by HG-FIAS analysis of total Se in digested plant roots and shoots.

XANES spectra of Se speciation within air-dried plant tissue revealed selenate uptake to be unchanged in shoots but transformed into organic compounds in the root while selenite uptake was found to be completely present as organic Se through shoots and roots of the plant.

Combining the results is crucial for mass balancing of Se speciation in a biogeochemical model of the Critical Zone."