

Thallium stable isotope fractionation in a model plant

A. VANEK^{1*}, O. HOLUBIK¹, M. MIHALJEVIC², V.
ETTLER², J. TRUBAC², A. VOEGELIN³

¹ Department of Soil Science and Soil Protection, Czech
University of Life Sciences Prague, Czech Rep.

(*correspondence: vaneka@af.czu.cz)

² Institute of Geochemistry, Mineralogy and Mineral
Resources, Charles University, Czech Republic

³ Eawag, Swiss Federal Institute of Aquatic Science and
Technology, Switzerland

Here, we studied thallium (Tl) isotope fractionation in white mustard grown hydroponically at different Tl doses. Thallium isotope signatures in plants indicated preferential incorporation of the light ²⁰³Tl isotope during Tl uptake from the solution. Negative isotope fractionation was even more pronounced in dependence on how much the available Tl pool decreased. This finding corresponds to the concept of isotope overprinting related to a high contamination level in the growing media (solution or soil). Regarding Tl translocation in plants, we observed a large Tl isotope shift with an enrichment in the heavy ²⁰⁵Tl isotope in the shoots relative to the roots in treatments with low/moderate solution Tl concentrations (0.01/0.05 mg Tl/L), with the corresponding $\alpha^{205/203}\text{Tl}$ fractionation factors of ~ 1.007 and 1.003 , respectively. This finding is probably a consequence of specific (plant) reactions of Tl replacing K in its cycle. The role of the S-coordinated Tl(I) complexes in the total process of Tl accumulation and Tl isotope fractionation in plants, however, still remains unclear, since we do not have indication for that on the basis of X-ray absorption spectroscopy, suggesting that Tl was mainly present as free/hydrated Tl⁺ ion or chemically bound to O-containing functional groups of (soluble) organic compounds.

In summary, our findings indicate that the tracing of Tl isotopes could be a tool how to better understand Tl transfers between the substrate and plant, but similarly to other trace metals, Tl speciation seems to play an important role in the strategies of Tl plant uptake/avoidance. However, these Tl processes should be verified by further experiments also with other plant species, more complex substrates and/or using more sophisticated approach depicting effects of individual physiological processes on Tl isotope shifts among individual plant parts.