Uptake and fractionation of thallium by Brassica juncea in geogenic Tl-amended substrate

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Our foundational work has shown a distinct mineralogic control on the geochemical signature of thallium (Tl) in geologic samples. Concentrations can vary at least three orders of magnitude, from below detection limit (<200 ppb) to nearly 200 ppm. This range spans values considerably higher than a typical crustal whole rock concentration of 0.7 ppm, with an enrichment factor of up to 5x in mica versus coexisting K-feldspar. Additionally, this work has also demonstrated that underlying mineralogy plays a vital role in Tl isotope ratios, with redox state thought to be a local control on fractionation. Sulfides consistently display significantly heavier ε^{205}Tl values compared with lighter coexisting feldspar and even more isotopically light mica samples. Overall, Tl isotope ratios have shown greater than 20ε variability among coexisting mineral phases.

Given the mineralogic control on Tl geochemistry, this applied study has focused on Tl uptake by *Brassica juncea* cultivated in silica sand with four Tl-amended substrates: 1) Amelia Courthouse, VA, USA amazonite 2) Sterling Hill, NJ, USA hendricksite 3) USGS reference material NOD-A-1 and 4) NIST 997 standard solution. Each of these substrates has been previously characterized for Tl concentrations and isotope ratios, allowing for the determination of fractionation and translocation after biologic processes. Utilizing multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) coupled with a two-stage extraction chromatography column procedure we are measuring Tl concentrations and isotope ratios among plant organs and calculating translocation and bioconcentration factors for each substrate.

Quantifying the extent of accumulation and fractionation induced by biologic activity is vital in understanding the utility of Tl geochemical markers. This information may be applied in biogeochemical prospecting, tracing anthropogenic contamination from source to sink, and phytoremediation.