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The Role of Redox State on Plant Biochemical Signatures using Thallium Isotopes

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Even in low concentrations, naturally present heavy metals (HM) can be detrimental to humans and the natural environment with exacerbated impacts for HM that are readily transferred into biological materials and thus introduced into the food chain. However, plants that readily accumulate HM may be able to identify metal contamination sources through isotopic analysis, tracking their transport through the plant and determining human exposure risk. Thallium (Tl) is one HM with simultaneous concern for human health (as ingestion even in very low concentrations results in acute illness) and the potential to serve as a metal provenance tool in plant biomass. Many HM, including Tl, have been shown to accumulate to a great degree in *Brassica juncea (B. juncea)*, a mustard plant that is naturally occurring in a variety of metal-contaminated environments and commonly grown in individual or regional garden plots for consumption. Here we present Tl isotopic data from greenhouse trials utilizing *B. juncea* to determine the ability of biological Tl signatures to reflect original geogenic sources and the impact that redox state may play on plant uptake, translocation, and fractionation.

Fifteen plants from three treatment groups (1) reduced Tl^{+} ($TlNO_3$), 2) oxidized Tl^{3+} ($Tl(NO_3)_3$), and 3) equal proportions of Tl^{+} and Tl^{3+}, all with total concentrations of 1 mg/kg) along with a control group were studied. Plants grown in Tl^{+}-spiked soils displayed higher [Tl] than those of the Tl^{3+} group with the highest [Tl] in the leaves and overall biomass concentrations ranging from ~1.7 mg/kg to ~66 mg/kg . Preliminary Tl isotopic ($\varepsilon^{205}Tl$) data demonstrate a broad range of isotopic compositions spanning over 10 $\varepsilon^{205}Tl$ units across plant parts (-14.1 to +0.3) with $\varepsilon^{205}Tl$ values decreasing in plant tissues that formed later in the growth period. Plants grown in the presence of reduced Tl have slightly lighter isotopic values than plants grow in the presence of oxidized Tl for the stems and flower stems, but comparable values for flowers and seedpods. Continued work aims to establish the potential role redox has on isotopic fractionation of various metals, with implications for provenance, remediation, plant-based metal mining and public health planning.