Thallium (TI) is a metal of great toxicological concern and its prevalence in the natural environment has steadily increased as a result of manufacturing and combustion practices. Due to its low natural abundance and the increasing demand, TI recovery and reuse could be a profitable endeavor. Thallium (TI) is an element with greater toxicity to mammals than Hg, Cd, Pb or Cu and is listed among the 13 priority metals by the USEPA. Little is known regarding the chemical speciation of TI in plants. However, this information is important because TI has two oxidation states, monovalent TI(I) and trivalent TI(III), which differ in terms of toxicity and chemical reactivity. TI(I) is similar in size and reactivity to potassium and, as such, is expected to compete with K in biological systems.

In this work we investigated in vivo TI speciation and distribution in leaves of the TI hyperaccumulator Iberis intermedia. This knowledge is valuable in view of the large potential of this plant for phytoremediation of TI-contaminated soils as reported by Anderson et al. The ability of I. intermedia to accumulate extremely large concentration of TI in the above ground biomass (up to 20 000 mg kg-1) makes this plant interesting in terms of phytomining. Currently, TI is the fourth most expensive metal after Pt, Au and Pd. Determining the oxidation state of TI in this plant is essential tQ assess disposal options and/or recycling possibilities of the metal-loaded plant biomass.

The distribution and speciation of TI were analyzed within the hyperaccumulator leaves by -XRF (X-ray fluorescence) mapping, synchrotron tomography, and -XANES (X-ray absorption near-edge spectroscopy). Thallium (12658 eV) LlII- -XANES spectra, tomography images, and -XRF maps were collected at the Advanced Photon Source at Argonne National Laboratory, Argonne, IL. Greenhouse studies show TI concentrations in I. intermedia shoots increased as TI concentrations in soil increased. Secondly, TI concentrations in I. intermedia were greater in mature (basal) leaves than young (apex) leaves. Although roots and stem represented almost 50% of the total weight of the plant, they contained only about 5% of the total TI accumulated by the plant. The majority (95%) of TI was stored in the leaves. Therefore, phytoextraction technologies must maximize the harvesting of this part of the plant, and removal of the root system may not be necessary. The synchrotron studies demonstrated that TI was localized in the vascular system of leaves (-XRF and tomography) as aqueous TI(I) (-XANES).

Determining the speciation and localization of TI in the hyperaccumulator I. intermedia to be similar to aqueous TI(I) within the vascular system of the leaves will aid in the next step of harvesting TI for beneficial reuse. Thallium(l) has a very low stability constant with both organic and inorganic ligands and therefore should be easily extractable from the leaves. As economic demand for TI increases, I. intermedia phytomining in TI-contaminated environments could be environmentally sound and financially feasible.