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XRF Tomography of Lead Distribution in Plant Root

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Beamline(s): X26A

Beamline X26A has recently begun a program in x-ray fluorescence computed microtomography (μCMT), a technique that can be used to determine elemental concentrations in materials in three dimensions. In many respects it can be thought of as a chemical CAT scan. For phytoremediation studies this technique provides a means of determining distributions of environmentally sensitive elements within plant tissue without the disturbance and potential contamination that sectioning samples can produce. In this study roots of a living plant (*Tagetes erecta* L.) were immersed in a solution of 95 mM Pb-EDTA complex. After 24 hours a 3 cm long, 0.2 mm wide section of root was removed and mounted vertically onto a goniometer for analysis by x-ray fluorescence tomography. It was scanned horizontally with a 14 micron spot size, an incident energy of 16 keV and count time of 0.1 seconds per pixel. After each horizontal scan the sample was rotated in 3° increments and the process repeated for a total rotation of 360° to yield a sinogram for a given fluorescence peak (Pb L_1) at a given elevation through the root. The sinogram is then back-projected to yield the reconstructed slice (Figure 1) of the Pb distribution in the root. An optical image of a stained section taken from near the tomographic section is shown in Figure 2, with clear correlation between physiologic features in the root and the Pb content as shown in the tomographic reconstruction. The reconstruction indicates that concentrations of Pb are greatest in interior portions of the root cortex while concentrations in the epidermis (which was directly exposed to the solution) are relatively low. Low concentrations are also seen in a small section of the stele where transport from the shoots may be bringing uncontaminated sap to the roots. For studies such as these μCMT provides a unique way of examining these samples. Not only is there no need to section the samples but the technique also holds great promise in allowing us to examine changes in elemental chemistry with time on living plants as the plant matures or contaminants or nutrients in soils are modified.

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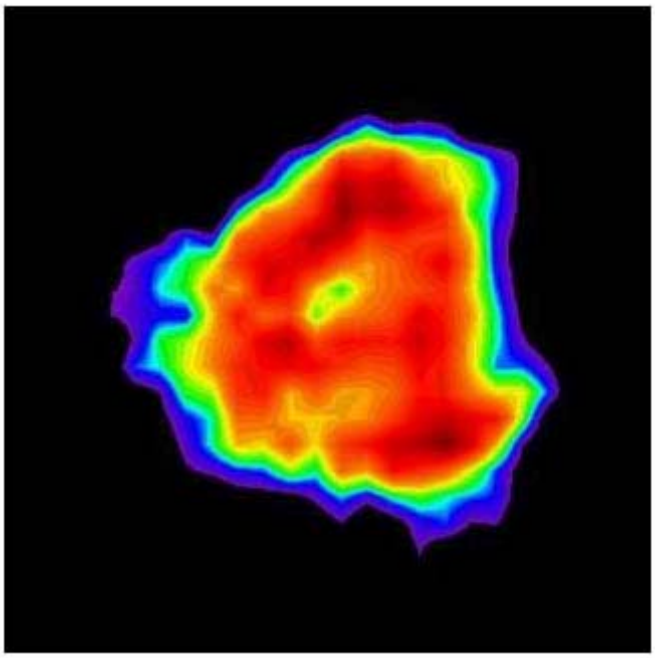

Figure 1. XRF tomograph of Pb distribution in Tagetes root. Highest concentration is dark red, lowest is blue.

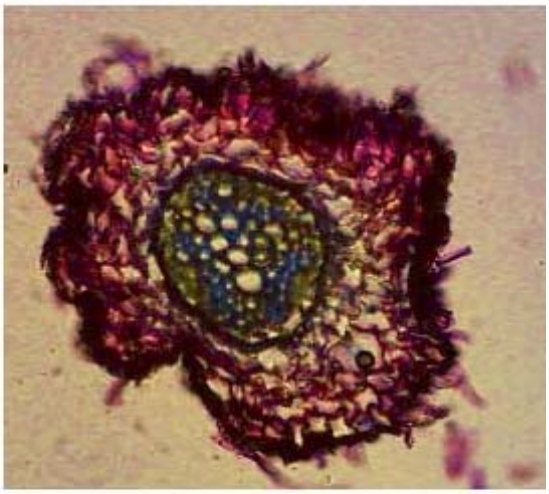

Figure 2. Optical image of a stained section of root from near the tomograph section.