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# Contaminated or just dusty? Understanding the nature of contaminants found in biomass grown on historic mine sites to inform pre-treatment options

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The aim of this study is to understand better how potentially toxic elements (PTE) interact with biofuel crops when they are grown on contaminated land. Bioenergy has considerable sustainability challenges to overcome including the risk of diverting farmland for biofuel production to the detriment of food supply. The use of contaminated land to grow bioenergy crops would increase the sustainability of bioenergy resulting in an increase in land available for energy crops whilst enabling the remediation of degraded soils and providing ecosystem services. It is important to understand how the biofuel plant is interacting with the PTE as this will inform pre-treatment options. The approach taken involved field trials of 648 pre-grown *Phalaris arundinacea* plants which were begun in 2018 in soils at a historic Pb-Zn mine site in the North East of England. Soils from this mine site were found to have very low levels of nutrients and very high levels of PTE (Pb and Zn >13000 mg/kg). The way that high density PTE phases (such as Pb minerals) interacted with the biomass was assessed with an innovative approach involving imaging the biomass with x-ray computed tomography (XCT). The use of the XCT allowed for greater understanding of the location and nature of the Pb within the biomass and is a frequently used non-destructive 3D imaging and analysis technique where X-rays are used to create a radiographic image of the scanned component. Whilst the use of this technique for 3D imaging of plant root and soil systems and in plant structures is increasing its application remains rare, particularly in the context of this study.

Plants in their third year of growth were sampled in a random pattern from the field trial in Summer 2022 by cutting with scissors at a height of 10cm. The sample was then divided equally with one left unwashed and another washed with HCl in a 1 molar solution and the surfactant Tween80. The biomass was then dried and a sample of both the washed and unwashed was selected for imaging with the XCT. The innovative use of the XCT has allowed for several key discoveries. Firstly, there are considerable numbers of high density dust particles across the biomass and concentrated in particular areas in the unwashed biomass (Fig 1). The density of some of this dust ~6g/cm$^3$ is similar to that of the expected Pb mineral forms (e.g. cerussite 6.58 g/cm$^3$). In the images of washed biomass, the high density dust remains in the joints between the “node” and leaf “sheath” of the plant. This is an important finding as it suggests that in order to achieve “clean” biomass from contaminated land, plants could be ground and then washed allowing the high density dirt to sink and be removed. Resulting far simpler pre-treatment procedure than if the PTE were found to have been absorbed into the plant by biological processes.

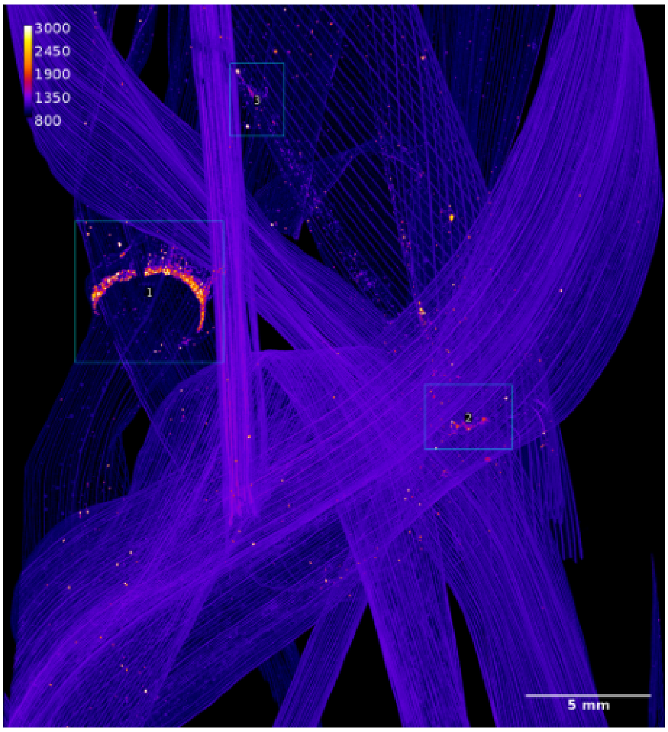


Figure 1 XCT image of unwashed Phalaris arundinacea

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