Abiotic Transformations of Metals by Engineered Biochar(s)

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(Bio)Chars, produced by the pyrolysis of biogenic feedstocks, are known for their large surface areas and broad functionality which renders them excellent for contaminant immobilization and resource recovery. In this study, oak wood (*Quercus Ilex*) biochar(s) were synthesized and modified by 1) introducing trace amounts of inorganic minerals (e.g. MgO, MnO_2) and 2) organic functional groups (e.g., thiols) into the carbon matrix. These *Functionalized Engineered Biochar(s)* show dramatic enhancement in specific metal (Pb, Hg and Au) uptake.

Wet chemical analyses were combined with electron microscopy and a suite of synchrotron-based X-ray techniques (scattering, spectroscopy and microscopy). Together they provide detailed insight into abiotic reduction mechanisms of metals in contaminated environments induced by environmental redox drivers (C, S, and Fe) embedded in Biochar carbon matrix. These studies also illustrate mechanisms for enhancement in metal uptake via surface complexation of metals with dopant minerals and activated carbon functional groups.

Our results demonstrate that combining surface complexation and redox capabilities of biochar(s) with chemical properties of 1) inorganic dopants and 2) functionalized organic ligands offer a powerful approach for waste management. Reaction mechanisms responsible for the immobilization of contaminants and recovery of precious metals under different geochemical conditions will be discussed.