



Localization of heavy metals immobilized on specific organic and mineral parts of a wood-derived biochar

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Biochar has been intensively investigated over recent years, not only as a promising carbon sequestration or fertilizing agent in soils but also as a possible new sorbent to remediate contaminated soils. A few studies have revealed its high potential for heavy metals immobilization depending on the nature of biochar and trace elements. The mechanisms behind this immobilization remain however unclear: some authors have hypothesized a high sorption capacity due to biochar large surface area while others have suggested that this immobilization is mainly due to soil pH increase. In particular, the distinction between heavy metals specific sorption in biochar pores and heavy metals precipitation in or outside biochar particles is often impossible to make while it is of primary importance to evaluate biochar ability to retain these pollutants on a long-time scale.

In order to evaluate the main heavy metal immobilization effects on a standard biochar and to identify the most successful biochar parts of the sample, we examined biochar particles after heavy metals immobilization in batch experiments designed to mimic real chemical processes in soils. A biochar derived from hard and soft wood and pyrolyzed at about 450°C was put in contact with relatively low concentrations of heavy metals (Pb, Cu, Cd, Zn, Ni) in an initially acidic $\text{Ca}(\text{NO}_3)_2$ solution. Following a one-week adsorption and a one-week desorption step, we recovered the biochar particles and observed them using scanning electron microscopy coupled to energy dispersive x-ray spectroscopy, focusing especially on the changes in mineral phases and the location of each of the retained heavy metals on biochar particles.

We were able to distinguish different structures in the biochar samples which were linked to the degree of pyrolysis and the exact nature of the raw wood biomass. We detected the presence of concentrated metals zones (e.g. lead) in specific locations of the organic particles depending on the original plant tissues, and enlightened metal associations with newly-formed mineral phases such as calcite present on biochar surface. These observations provide new insights in the understanding of metal immobilization mechanisms on biochar such as precipitation and co-precipitation. Our findings also underline the need to consider the heterogeneity of biochar constitution for optimizing the remediation potential of biochar on contaminated sites.