Oral

Effects of laboratory-simulated fires on the distribution and speciation of chromium in agricultural soils: An integrated investigation approach

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Controlled fires are widely used in many common agricultural practices to remove the vegetation residues and manage weeds and pests. High temperatures occurring during fire events can cause significant changes in soil physico-chemical properties and element biogeochemistry. Therefore, also potentially toxic elements (PTEs) can change their speciation and hence their bioavailability. In particular, chromium (Cr), depending on the soil red-ox conditions and the content and type of organic matter (OM), can modify its oxidation state thus forming highly mobile and toxic hexavalent species (Cr(VI)). In the present study, the effect of laboratory-simulated fires on the distribution and speciation of Cr in highly polluted soils was investigated. Three thermal treatments (up to 300°C, 400°C and 500°C) were performed by means of a muffle furnace to simulate a fire event of medium severity. The soil chemical and mineralogical characteristics were assessed before and after each thermal treatment, as well as the Cr fractionation and speciation. The latter were assessed through an integrated approach based on conventional analyses (determination of total Cr, total Cr(VI), and exchangeable Cr(VI), DTPA extraction, BCR sequential extractions), and X-ray based techniques, including synchrotron X-ray absorption spectroscopy (XAS). Heating treatments strongly altered the soil chemical characteristics, especially the OM content and Cr fractionation and availability. After heating, a partial oxidation of Cr(III) to Cr(VI) was observed, and from 21% to 88% of the total Cr(VI) was in the exchangeable form. A combination of bulk and micro X-ray Absorption Near Edge Spectroscopy (XANES) analyses allowed the identification of different Cr species in the polluted soil samples before and after the thermal treatments, showing an increase of chromite ($FeCr_2O_4$), Cr(III)-goethite and $CaCrO_4$ with increasing temperature, and a decrease of Cr-OM complexes. The formation of Cr-goethite and chromite caused a relative immobilization of Cr, while $CaCrO_4$, being slightly soluble, could represent a potential risk for the environment with negative consequences for plants and human health.