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Thallium Behavior in Soils Polluted by Pyrite Tailings (Aznalcóllar, Spain)

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Thallium content and chemical speciation was studied at 91 sites contaminated by water and tailings spilled from the settling pond of a pyrite mine into the Agrio and Guadiamar rivers in Aznalcóllar (Spain). The contamination was highly heterogeneous, with 15% of the affected area seriously contaminated, 55% moderately contaminated and 30% uncontaminated. The total Tl content in the surface horizon increased with respect to the background level, more than 4-fold in the uppermost 10 cm of the soils, and clearly decreased with depth without contaminating either the subsoil or groundwater. Most of the Tl (approximately 75%) was in non-extractable forms, either as a component of the particles in the tailings or adsorbed to crystalline oxides. The remaining Tl was held on, or occluded in, amorphous or poorly crystallized oxides. In acidic soils, the adsorption of Tl was dominated by iron oxides (Feo) and, in neutral-alkaline soils, by aluminium oxides (Alo). A relatively high amount of the Tl adsorbed by amorphous oxides in the uppermost 10 cm of the soils was extracted with acetic acid, and was presumably bio-available (mean values approximately 15% of the Tlo). The EDTA is a strong extractant of inorganic forms of aluminium and, consequently, the quantity of Tl extracted by EDTA in neutral-alkaline soil (mean values more than 10% of the total Tl) could be higher than the truly bio-available fraction. Approximately 1% of the total Tl was extracted with calcium chloride, but only in the neutral-alkaline soil was the extraction significantly related to the cation-exchange capacity and, thus, adsorbed by the negative charges of the clay and organic matter. The Tl soluble in water (<0.1%) declined with the pH in the neutral-alkaline soils, and was unrelated to any soil property in the acid soils. Thus, the behavior of Tl is determined by climatic conditions, soils properties and time.

Keywords Pyrite tailings, soil pollution, thallium, speciation.

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