



Arsenic mobility in soils impacted by tailings at Zimapán, México

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The Zimapán mining zone, in Central México is one of the worldwide sites known for As contamination. For more than 20 years and until recently, As-rich groundwater, mainly due to mineralization in a limestone aquifer, was an important source of As exposure to the inhabitants. In addition, decades of ore processing have produced hazardous wastes (tailings), many of them settled in the town outskirts. Although mineralogical and chemical differences exist among the various deposits; every one has high As contents (up to several thousands mg/kg) and other toxic elements that may be released to the nearby soils. To assess As mobility in soils impacted by tailings, total and sequential fractionation determinations were performed in 120 superficial and 40 cm depth samples collected at various distances near three of the impoundments. Higher total As concentrations were measured in the dry (up to 51,534 mg/kg) with respect to the rainy season (up to 23,570 mg/kg) indicating the occurrence of As wash off by rain. Although concentrations were lower in the deep regarding the superficial samples at most sites, As contents reached several thousands mg/kg at 40 cm depth indicating also its vertical transport that may reach the shallow aquifer. Sequential extractions showed differences between soils impacted by highly oxidized (red) tailings and low oxidized (gray) deposits. Most of the As occurs in the Fe-Mn oxides fraction (up to 92%) followed by the organic matter and sulfides fraction (up to 52 %) in soils close to red tailings, while organic matter and sulfide fraction contain most of the As (up to 95%) in soil samples close to low-oxidized deposits. Arsenic proportion in the residual fraction increased with distance from oxidized tailings. Low pH values (from 2.0 to 2.5) in superficial soils revealed the influence of acid mine drainage at distances up to 40 m from the red deposit. In contrast, the lowest pH was 7.1 in soils impacted by low-oxidized deposits, reflecting the limestone environment. Arsenic airborne transport was evidenced by the presence of a total As concentration of 30,780 mg/kg in soils collected at 120 m in front of the tailings crossing a ravine. Although sequential extraction showed that most of the As is present in relatively low-mobility fractions, total As concentrations indicate that tailings impoundments constitute another source of environmental As exposure.