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Study of contaminated soils of the abandoned Pb, Zn, Cd Jebel Ressas mine tailings (North eastern Tunisia)

R. Souissi (1), M. Munoz (2), F. Souissi (1), P. Courjault-Radé (2), and A. Ben Mammou (3)

(1) Laboratoire des Matériaux Utiles, Institut National de Recherche et d'Analyse Physico-chimique, 2020 Ariana, Tunisie, (2) Université de Toulouse-UPS-CNRS-IRD, GET, 14 avenue E.Belin, 31400 Toulouse, France, (3) Laboratoire des Ressources Minérales et Environnement, Faculté des Sciences de Tunis, 2092 El Manar, Tunisie

Under semi-arid climatic conditions, Pb, Zn and Cd bearing particles are carried by wind and water from the flotation tailing heaps of the former Pb-Zn mine of Jebel Ressas towards the surrounding agricultural areas. The risk of ecotoxicity depends on the phytoaccessible fraction of metals which is closely related to their physico-chemical and biological environment. The objective of this study is to assess the contamination of soils surrounding the waste dumps and to estimate the bioaccessible fraction of metals present in these soils. These silty soils are mainly composed of calcite (45 % $CaCO_3$) and clays. Metal bearing minerals are hemimorphite ($Zn4Si2O72H_2O$), cerussite ($PbCO_3$), and smithsonite ($ZnCO_3$).

The flotation tailings display high amounts of Zn, Pb and Cd, averaging 7.11%, 2.30% and 290 mg.kg-1, respectively. The concentrations found in soils reach 6.3% Zn, 2.3% Pb and 290 mg.kg-1 Cd. Such results show that the soils in the mining area are highly contaminated by heavy metals coming from the mining wastes.Analyses of samples taken between surface and bedrock show that Pb and Zn may reach concentrations as high as 900 mg / kg two meters below surface.

Three types of simple extraction tests (deionized water, HCl solution at pH 2.8 and a mixture of organic acids (low-molecular-weight organic acids (LMWOAs) at pH 2.8) were performed to assess the phytoaccessibility of Zn, Pb and Cd in two contaminated soil samples collected within the study area. The results of extraction with deionized water showed that only Zn is mobile with 1.50 to 2.92 mg.kg-1 released from soil. During the extraction with HCl 1.32 to 1.63 mg.kg-1 of Pb are released. The extraction with LMWOAs resulted in a much greater leaching of all heavy metals. Indeed, 900 to1500 mg.kg-1 Zn, 33 to 40 mg.kg-1 Pb and 3.5 to 2.01 mg.kg-1 Cd, have been released respectively. Thus, the mobility of these metals is as follows: Zn (2.2%) > Cd (1%) > Pb (0.2%). As a result, the mobilization of contaminants by organic acids secreted by plants in the rhizosphere is potentially higher than that achieved in the presence of percolating waters or mineral acids of the same pH. The leaching tests with organic acids, simulating reactions in the rizhosphere and SEM observation of this one, show the presence of Pb and Zn spherules precipitated nearby the roots.