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Mineralogical characterization of tailing dams: incidence of abandoned mining works on soil pollution (Linares, Jaén)

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The metallogenic district of Linares-La Carolina (Jaén, Spain) consists of dyke mineralizations mainly of galena, accompanied by blende, chalcopyrite and barite. Associated to these abandoned mines, relatively extensive areas occupied by spoil heaps and tailing impoundments exist and constitute potential sources of soil pollution by metals and semimetals. In order to analyze the pollution potential of these mining wastes, we have carried out a mineralogical and geochemical study of seven tailing dams and surrounding soils in the area. The mineralogy of the samples was studied by x-ray diffraction (XRD) and scanning electron microscope (SEM). In addition, the total metal content of samples was determined by inductively coupled plasma mass spectrometry (ICP-MS) analysis. Samples were taken from the first 30 cm of the waste piles and soil deposits and white efflorescences were also obtained from the surface of the tailings. In all analyzed heaps, high to very high total contents in Pb (1220-22890 mg/kg), Zn (150-51280 mg/kg), Mn (2658-4160 mg/kg), Ba (1026-19610 mg/kg) and Fe (19400-138000 mg/kg) were observed. The concentrations for these same elements in the studied soils range from 527-9900 mg/kg for Pb, 27-1700 mg/kg for Zn, 506-2464 mg/kg for Mn, 2832-4306 for Ba and 8642-29753 mg/kg for Fe, and these figures indicate a contamination of the soils, according to the guidelines established by the Spanish law. The XRD and SEM results indicate that the tailings are primarily constituted by gangue of the exploited mineralization: quartz, calcite, ankerite, feldspars and phyllosilicates. They are inherited, primary mineral phases. Galena, also primary, appears in low proportion, as well as lepidocrocite, melanterite and cerussite, being these three last secondary minerals and indicating a certain remobilization of metal cations, especially lead and iron. On the other hand, quartz and phyllosilicates predominate in the soils, in which, in addition, is identified a little proportion of galena (primary mineral) and ferro-hexahydrite, also indicating mobilization of Fe. As regarding white surface blooms, they are formed mostly of magnesium sulphate with different hydration states. The morphology of these mineral precipitates reveals that they have been subject to cycle of washing and subsequent dehydration, which indicates that these phases present a great mobility in the environment, and they may be contributing to the transport of metals from the tailings into the surroundings soils.