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Geo-environmetal characterization of dry riverbeds affected by mine tailings in the Mazarrón district, Murcia (Spain)

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Mine tailings constitute an environmental issue of public concern because they represent accumulations and emission sources of heavy metals and acid mine drainage by sulphide oxidation. In this work, two geophysical methods, electrical resistivity tomography (ERT) and ground-penetrating radar (GPR), as well as mineralogical and geochemical techniques have been used in order to obtain a geo-environmental characterization of two dry riverbeds in a mining district. The abandoned San Cristóbal and Los Perules mining group (Mazarrón, Murcia) has generated a huge amount of sludge from the Ag, Pb and Zn extraction operations. These tailings were piled up in ponds or directly dumped to the San Cristóbal dry riverbed located at the mining site, and Las Moreras dry riverbed, where San Cristóbal flows into a few meters downstream. Furthermore, Las Moreras watercourse flows into the Mediterranean Sea five kilometres downstream.

Samples from two boreholes have been analyzed in order to obtain thickness, mineralogical and chemical composition of tailings and watercourse sedimentary materials affected by them. San Cristóbal sampling point shows a thickness of 3,5 m of mine tailings, 2 m of sedimentary materials, and the in situ volcanic rocks to 5,5 m depth. Las Moreras site shows a thickness of 2 m of a mine tailings deposit, 4 m of sedimentary materials, and the in situ metamorphic rocks 6 m depth. In both sites, significant amounts of pyrite (15-20 wt %), sphalerite (10-15 wt %) and galena (5-10 wt %) have been determined, and secondary oxides (hematite) and sulphates (gypsum, jarosite) minerals have been also identified. Ag, As, Cd, Co, Cu, Sb, V, Pb and Zn contents are also significant in all studied samples from tailings samples, and acid mine drainage has been clearly detected affecting the San Cristóbal dry riverbed. Regarding the alluvial materials from the riverbeds, pyrite, sphalerite and galena have been only identified in the San Cristóbal sampling point, probably due to its location at the mining site. Furthermore, heavy metal content of both dry riverbeds show significant amounts of Ag, As, Cu, Sb, Pb, V and Zn, indicating an important process of contamination from the surficial tailings to the natural sediments and watercourses. Water from Las Moreras riverbed has also been analysed. Its pH is about 8 and it exhibit higher values in conductivity and TDS, together with the concentrations of major metallic ions, mainly Cu, Ni, Fe and Zn, most of them beyond the established limits for this kind of natural waters.

ERT and GPR techniques have provided estimations of both thickness and internal structure of the dry riverbeds infilling. For San Cristóbal site, ERT indicates a $\sim$6 m thick sedimentary sequence, in good agreement with borehole data. An upper unit of 30 ohm.m extending up to 1.5 m depth, and a lower unit of resistivity values lower than 5 ohm.m up to 6 m depth can be distinguished. The first unit corresponds to upper part of the tailing, characterized by sand texture, whereas the lower one corresponds to tailing with silty-clay texture and sedimentary material with high metal contents. For Las Moreras site a 2 m thick upper unit of low (< 5 ohm-m) resistivity values and a 4 m thick lower one of $\sim$20-30 ohm.m are distinguished, in good agreement with the surficial tailings and lower sedimentary materials obtained in the borehole.

Joint application of geophysical and geochemical techniques has revealed itself as very useful for obtaining a complete characterization of abandoned mine deposits, previously to a future reclamation of these dangerous tailings.