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Geophysical investigation of heavy metals spatial distribution in mine tailings ponds, Cartagena-La Union district in Sierra Minera, SE Spain

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The Sierra Minera, constitute the southeast end of the Betic range (Murcia region, Spain). Decades of mining activity (mainly Zn and Pb) in the area of Cartagena and La Union cities generated a large amount of mine tailings ponds, most of them were abandoned without safety measure. They are composed of unhealthy mining wastes and are environmental hazards due to their high susceptibility to leaching and erosional processes (e.g. flash floods, slope diffusion, aerial transport). Our study focuses on the mine tailings pond in the Avenque watershed close to Cartagena, which was locally remediated by adding pig slurry/manure and marble residue (sand). Such rehabilitation was done to improve physical, chemical, and biological conditions of the soil to guarantee the immobilization of heavy metals, and the development of plants essential for the formation and evolution of such soils.

We present preliminary geophysical measurements and geochemical soil analysis performed to characterize the surface and deep properties of a partially remediated mine tailings pond. We used an EM38 electromagnetic induction meter to measure the apparent electrical conductivity and susceptibility of soils and field portable X-ray fluorescence spectrometer to map and estimate the surface contamination of remediated and common mining wastes. We combine surface measurements with electrical resistivity tomography to establish the spatial distribution of the contamination within the mine tailings pond. We also investigate the potential of GNSS-Reflectometry which consists to recover the electromagnetic signals emitted continuously by the GNSS satellites and then reflected on the Earth surface to map soil properties of the tailings ponds (heavy metal concentration in dry condition and very low roughness). We used GNSS multipath that corresponds to an interference of the ground reflected wave in the remediation zone with the direct wave that adds new frequencies affecting the GNSS Signal Noise Ratio (SNR) recorded by the receiver during 2 days for a complete coverage of the remediation area. The ground contamination affects the composition of soil that can be quantified using GNSS-Reflectometry by measuring electric conductivity changes due to the variation of heavy metal concentration and assuming a quite constant permittivity for this type of soil.