Evaluation of 3D Ground Penetrating Radar Efficiency for Abandoned Tailings Pond Internal Structure Analysis and Risk Assessment

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Abandoned tailings ponds constitute a severe environmental problem in old Pb mining districts due to their high contents in metallic and semi-metallic elements. In most of the cases, there is a lack of information about the construction procedures and the previous environmental situation, which hinders the environmental risk evaluation. In these cases, Ground Penetrating Radar (GPR) could be an interesting technique to analyze the internal structure of the tailings ponds and detect vulnerable zones for leaching processes. Consequently, the GPR could help in the abandoned tailings ponds environmental risk assessment.

In this study, a GPR 3D campaign was carried out with a 250 MHz frequency antenna in order to evaluate the efficiency of this technique in both the analysis of internal structures and the environmental risk assessment. Subsequently, 2D and 3D models were undertaken to represent graphically the obtained results.

The studied tailings pond is located in the Guadiel river bank, a water course draining the mining district of Linares, Spain. The dam is 150 m length and 80 m width. The GPR 3D was done in a selected area near the central part of the pond. The analyzed grid was 25x50 m and the spacing of the slides was 1 m.

The study revealed that the contact between the tailings and the substratum is located at 2.5 m. No intermediate layer was found, which means that the tailings pond was heightened on the fluvial terrace without any insulation system.

Inside the first meter of the pond, a cross stratification was identified. The orientation of those laminations changed with the depth, which means that the stockpiling was performed from the different sides of the tailings pond. Furthermore, the direction of these stratifications is slightly concentric to the middle of the dam which could be associated with a central drainage system. Therefore, the internal zone of the tailings pond appears to be the most vulnerable for leaching processes that could contaminate the groundwater.

Thus, this technique gave detailed information of the internal structure at the first meters despite the rapid attenuation of the GPR signal. In consequence, the GPR 3D with 250 MHz antenna appears to be effective for the detection of the tailings ponds cross stratification and the tailings-soil contact in dams with less than 5 meters of thickness.