Geophysical investigation using the GPR method: a case study of a lead contamination in Santo Amaro, Bahia, Brazil

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The town of Santo Amaro, in the state of Bahia, Brazil, presents a history of contamination, mainly of lead (Pb) originating from the intense activity of metallurgical extraction by the mining company “Plumbum-Mineração e Metalurgia Ltda.” between the years of 1956 and 1993. Over this period, the lead slag was deposited carelessly in the factory area, creating a huge hazardous waste site. Subsequently, the problem increased when this slag was used as the basis for the paving of city streets, gardens, and school yards due to its granular characteristic and good support capacity. However, the ongoing need to remove the street paving for work on the water and sewage networks requires the exposure of the slag, making it a source of active contamination. In this context, the Ground Penetrating Radar (GPR) method was used as a tool to support and guide the evaluation of the existence of anomalous areas associated with the source of local contamination (slag) under the paving. In this work the data was acquired by moving the GPR using the of constant offset technique and a sampling interval of 5 cm between the traces. The shoots and trace records were registered continuously with the use of a calibrated wheel. The results obtained by this study show the potential of applying the GPR method to the environmental characterization of the subsoil of paved streets, making it possible to identify the resistive material contaminants (lead slag) as well as the various layers: paving, soil-slag, and massapê soil. These layers are characterized by distinct reflection patterns. The first observed reflection pattern has high amplitude with horizontal and continuous reflectors, which correspond to a characteristic pattern of urban street paving. The second reflection pattern is characterized by reflectors with amplitude variations (horizontal and inclined, continuous and discontinuous), which indicate the heterogeneity of the medium and corresponds to the soil pattern mixed with the resistive slag material. The third reflection pattern is characterized by low amplitude with chaotic and totally discontinuous reflectors, and occurs just below the second reflection pattern. This pattern of reflection marks the region in which the electromagnetic GPR signal is absorbed by the medium. This absorption is an effect of the attenuation of the electromagnetic signal by the presence of electrically conductive layers of the characteristic massapê soil (clayey to very clayey) of the study area. GPR data also enabled the identification of reflectors associated with anthropogenic interferences (manholes, train lines, pipelines, etc.). Borehole samples confirmed the existence of the contaminant (lead slag). Anomalous concentrations of heavy metals, mainly lead, were observed in the locations indicated by geophysical results using the GPR method, showing the importance of the use of geophysics in environmental characterization programs.