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# The Use of Ground Penetrating Radar and Electrical Resistivity Imaging for the Characterisation of Slope Movements in Expansive Marls

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Slope movements are one of the natural hazards that most affect linear projects, becoming an important waste of money and time for building companies. Thus, studies to identify the processes that provoke these movements, as well as to characterise the landslides are necessary. For this purpose, geophysical prospecting techniques as Ground Penetrating Radar (GPR) and Electrical Resistivity Imaging (ERI) could become useful. However, the effectiveness of these techniques in slope movement characterisation is affected by many factors, like soil humidity, grain size or failure plane depth. Therefore, studies that determine the usefulness of these techniques in different kind of soils and slope movements are required.

In this study, GPR and ERI techniques efficiency for the analysis of slope movements in Upper Miocene expansive marls was evaluated. In particular, two landslides in an old regional road in the province of Jaen (Spain) were studied.

A total of 53 GPR profiles were made, 31 with a 250 MHz frequency antenna and 22 with an 800 MHz frequency antenna. Marl facies rapidly attenuated the signal of the electromagnetic waves, which means that this technique only provided information of the first two meters of the subsoil. In spite of this low depth of penetration, it is necessary to point out the precision and detail undertaken. Thus, both GPR antennas gave information of the thicknesses and quality-continuity of the different soil layers. In addition, several restoration phases of the linear work were detected. Therefore, this technique was useful to detect the current state and history of the structure, even though it could not detect the shear surface of the slope movement.

On the other hand, two profiles of electrical tomography were made, one in each studied sector. The profiles were configured with a total length of 189 m, with 64 electrodes and a spacing of 3 m. This allowed investigating up to 35 m depth. This penetration capability enabled to detect the depth of the shear surfaces and therefore the minimum depth at which the possible piles should be placed in the design of the restoration structures. Thus, this method was more effective than the GPR for the detection of slope surfaces in uniform expansive marls. Nevertheless, the GPR was efficient for the analysis of the previous restoration phases, which was helpful to determine any relation between them and the causes that provoked the slope movements.