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Application of electrical resistivity tomography techniques for mapping man-made sinkholes

J. Rey (1), J. Martínez (2), C. Hidalgo (3), and J. Dueñas (4)

(1) Department of Geology, EPS Linares, University of Jaén, Spain (jrey@ujaen.es), (2) Department of Mechanical and Mining Engineering, EPS Linares, University of Jaén, Spain (jmartine@ujaen.es), (3) Department of Geology, EPS Linares, University of Jaén, Spain (chidalgo@ujaen.es), (4) Department of Graphical Engineering, Design and Projects, EPS Linares, University of Jaén, Spain (jduenas@ujaen.es)

The suitability of the geophysical prospecting by electrical resistivity tomography to detect and map man-made subsurface cavities and related sinkholes has been studied in the Linares abandoned mining district (Spain). We have selected for this study four mined sectors constituted of different lithologies: granite and phyllites of Paleozoic age, and Triassic shales and sandstones. In three of these sectors, detail underground topographic surveys were carried out to chart the position and dimensions of the mining voids (galleries and chamber), in order to analyze the resolution of this methodology to characterize these cavities by using different electrode arrays. The results are variable, depending on the depth and diameter of the void, the selected electrode array, the spacing between electrodes, geological complexity and data density. These results also indicate that when the cavity is empty, an anomaly with a steep gradient and high resistivity values is registered, because the air that fills the mining void is dielectric, while when the cavities are filled with fine grain sediments, frequently saturated in water, the electrical resistance is lower. In relation with the three different multi-electrode arrays tested, the Wenner-Schlumberger array has resulted to offer the maximum resolution in all these cases, with lower and more stable values for the RMS than the other arrays. Therefore, this electrode array has been applied in the fourth studied sector, a former mine near the city centre of Linares, in an area of urban expansion in which there are problems of subsidence. Two sets of four electrical tomography profiles have been carried out, perpendicular to each other, and which have allowed reaching depths of research between 30-35 m. This net-array allowed the identification of two shallow anomalies of low resistivity values, interpreted as old mining galleries filled with fine material saturated in water. It also allows detecting two fractures, correlated in the profiles and which can be mapped to more than 25 m in depth. As showed by this case study, electrical resistivity tomography can be a suitable tool in sub-surface cavities detection and man-made sinkhole investigations.