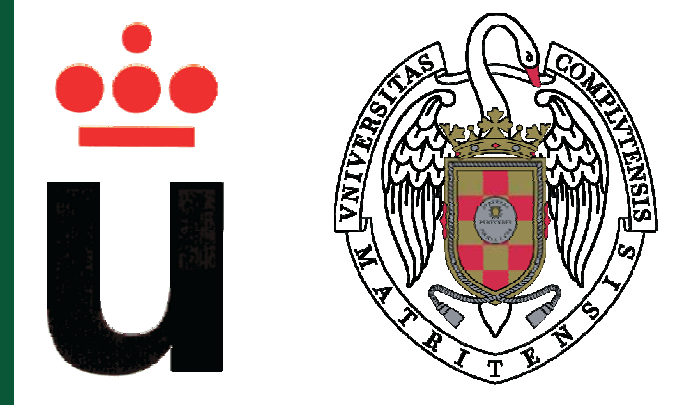


Geoenvironmental characterisation of mine tailings: pond and watercourse sediments from the Cartagena-La Unión district (Spain)



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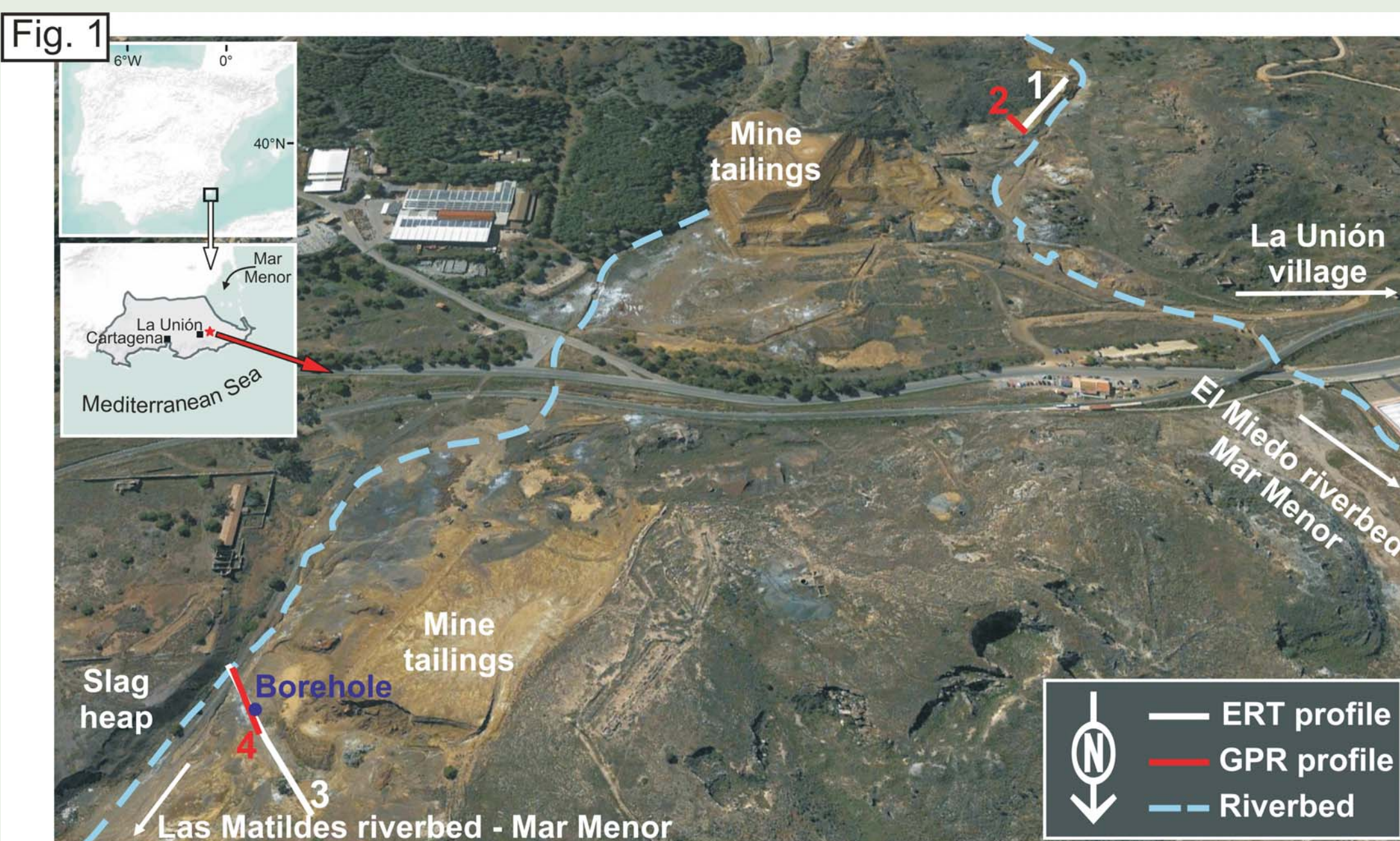


INTRODUCTION

This study presents the results of the geoenvironmental characterization of Descargador watercourse, affected by mine tailings in the Cartagena-La Unión district, Murcia (SE Spain). The main objective of the study was to characterize the present conditions of abandoned mine tailings and watercourse in order to identify environmental hazards. The goal is particularly relevant, because the abandoned mine wastes remain a continual source of AMD and metal contamination. Soils and watercourse in this area are still highly polluted

Two different near-surface geophysical methods, Electrical Resistivity Tomography (ERT) and Ground Penetrating radar (GPR) has been used to obtain information about both the thickness of the deposits and its internal structure. 2 ERT profiles have been carried out (1 longitudinal to the mine pond a 1 transverse to the watercourse).

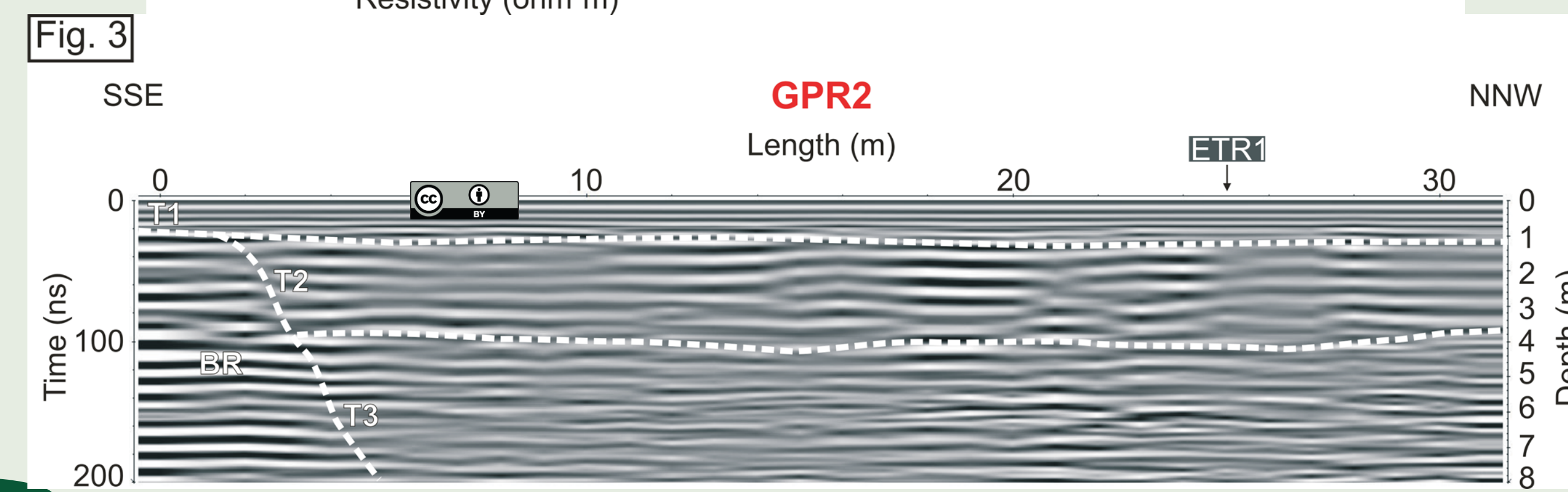
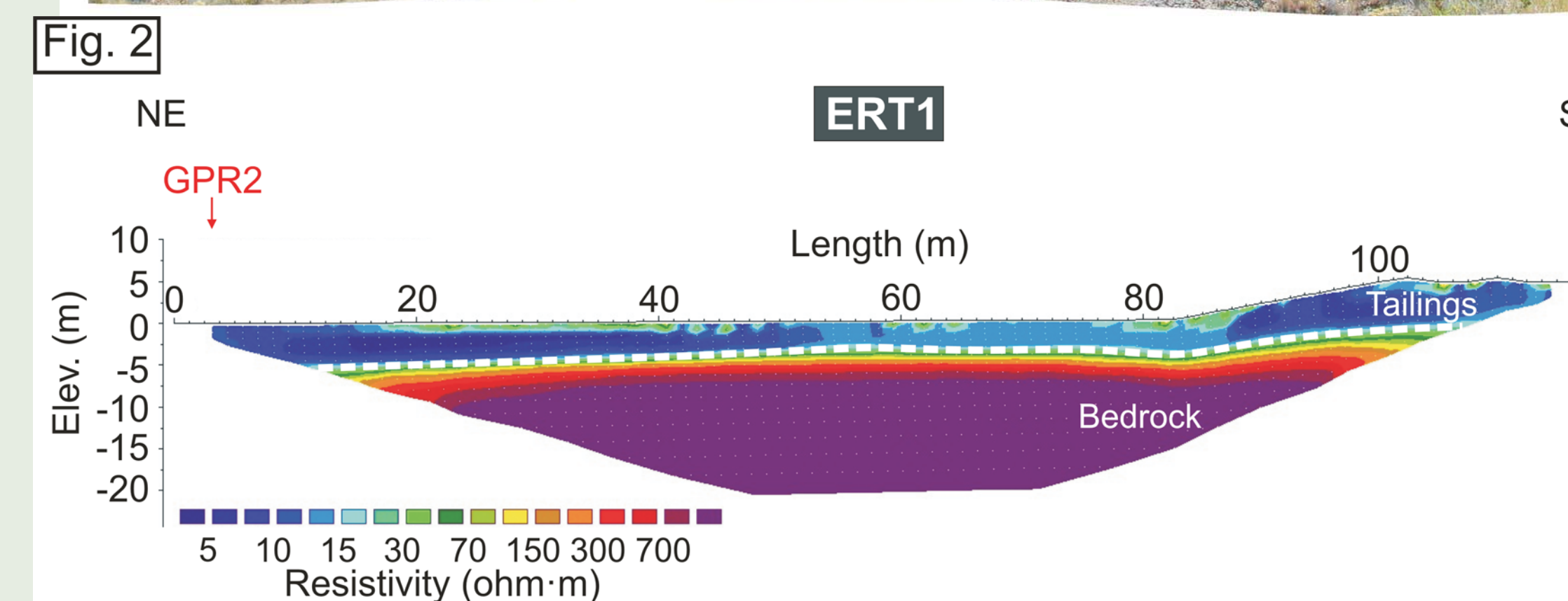
To obtain more detailed information about the internal structure of the deposits, 4 GPR profiles (3 in the mine pond and 1 transverse to the watercourse) using both 100 Mhz and 200 Mhz frequency antennae were acquired.



GEOPHYSICAL SURVEY: MINE POND

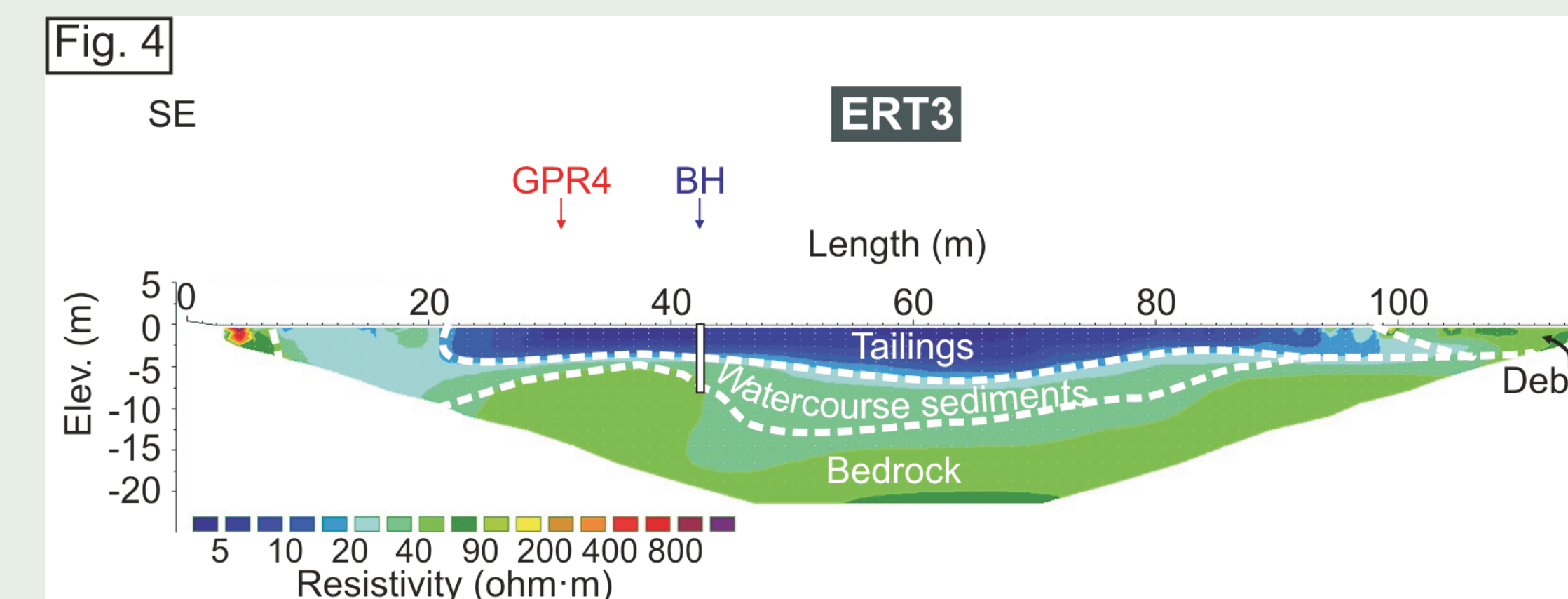
Using a Wenner-Schlumberger array to combine a good resolution and investigation depth, 1 ERT profile has imaged two different units: the upper one is characterized by low resistivity (<20 ohm·m) values and a thickness ranging from 5-8 m. It can be correlated with the mine tailings deposits. The lower unit is more resistive (>200 ohm·m) and corresponds to the Paleozoic metasediments that constitute the bedrock.

A GPR profile transverse to the mine pond has imaged up to four different units. The bedrock (BR) appears as strong reflections along the first 5 m of the profile that vanishes laterally, imaging the topography of the fluvial valley that was filled with the mine deposits. Three subhorizontal continuous units (T1-T3) can also be seen corresponding to levels with different textural properties defining the internal structure of the mine tailings. T1 is characterized by very homogenous and continuous reflections up to 1m depth. T2 has a thickness ~3m and is defined by slightly undulating reflections with laterally varying amplitude. T3 is at least 4 m thick and has similar characteristics to T3 but with a large noise content an lower amplitude values in general.

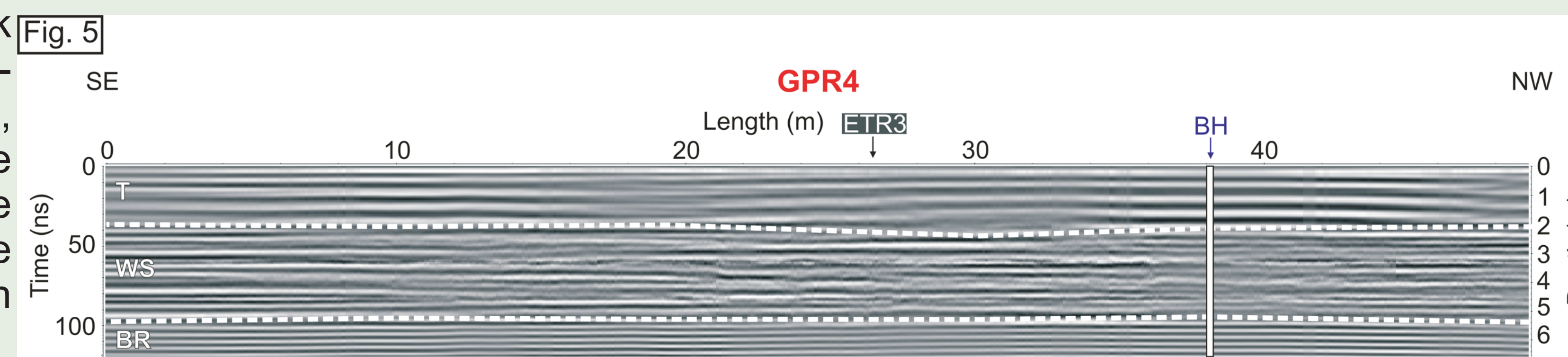


GEOPHYSICAL SURVEY: DRY RIVERBED

The ERT profile transverse to the dry riverbed has revealed the existence of three different units. The uppermost one, with a mean thickness of 2-3 m, extends from 21 to 100 m along the profile, and has the lowest resistivity values (<15 ohm·m). It corresponds to the tailing deposits transported episodically by the riverbed during the periods of strong rainfall. An intermediate unit, with resistivity values ranging from 15 to 40 ohm·m and varying thickness (1 to 4 m), corresponds to the watercourse sediments previous to the construction of the mine tailings located upstream. The lower unit is more resistive (>50 ohm·m) and corresponds to the bedrock. Two small heterogeneous high resistive (>200 ohm·m) units located at both ends of the profile can be associated with debris deposits from the neighbor slag heap.



The GPR profile has imaged the same three layers structure as in the ERT profile. The upper one (Tailings) is characterized by thick subhorizontal reflections with a convex-upwards geometry. The intermediate one, (Watercourse Sediments) has more discontinuous reflections with higher noise content. The lower one corresponds to the bedrock and is characterized by thin subhorizontal continuous reflections.

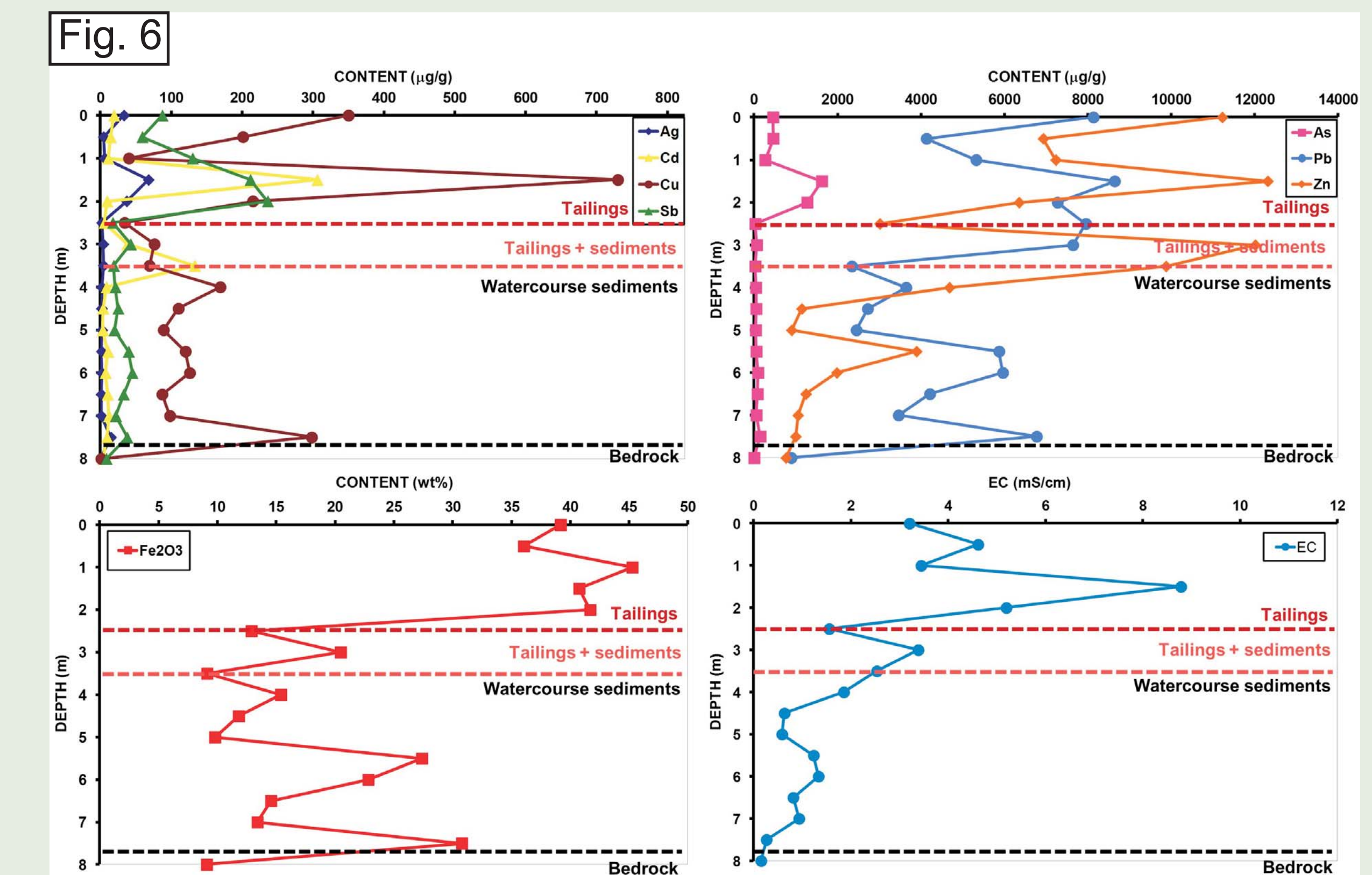


MINERALOGY AND GEOCHEMISTRY

Non-disturbed rock drill core samples were collected (with a constant spacing of 0,5 m) from a borehole (BH) up to a sampling depth of 8 m in the Las Matildes dry riverbed. The deepest sample was the bedrock.

The sampling showed thicknesses of 2 m of reddish clayed mine tailings, 1.5 m of tailings mixed with watercourse sediments, and 4 m of coarse to sandy watercourse sediments. Significant amounts of pyrite, sphalerite, and galena from the mined ore deposit have been identified in all levels, showing bigger amounts in the mine tailings upper levels (10%) than in the watercourse sediments lower level (5%), probably related to the poor ore benefiting processes in the early stages of the mining activity. Anglesite (5%) were determined in all samples. Fe-carbonates, and secondary Fe-sulphates and Fe-oxi-hidroxides have been determined at the mine tailings upper levels.

Consequently, significant toxic metal and metalloid contents (As, Cd, Cu, Fe, Pb, Sb and Zn) have been determined in mine tailings and watercourse sediments. They could potentially release substantial amounts of potentially toxic elements to the surrounding environment. And finally to the Mar Menor coastal area, a major tourism location in SE Spain.



CONCLUSIONS

The geophysical methods have allowed determining both the thickness and the internal structure of mine tailings and a dry riverbed. ERT provides reliable estimation of the thickness and GPR detailed information about the internal variations in texture inside them.

The geochemical composition of borehole samples shows significantly high contents of As, Cd, Cu, Fe, Pb, Sb, and Zn, that could potentially released to the surrounding environment. The manifest environmental hazards related to the mine tailings make necessary works on remediation and monitoring to minimize environmental impact on the areas affected, in one of the most touristic areas in SE Spain. Permanent monitoring of irrigation and drainage waters flowing into the Mediterranean Sea and of its leisure and bathing areas must be carried out by the authorities.

Joint application of geophysical and geochemical techniques has revealed itself as very useful for obtaining a complete characterization of abandoned mine deposits, previously to a future reclamation of these dangerous tailings.