Combined ERT and GPR for Laboratory Modelling Experiment

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ABSTRACT

In this research it is aimed to experimentally elaborate a modeling study for an artificial aquifer and examine its response to the Electrical Resistivity Tomography (ERT) and Ground Penetrating Radar (GPR). The compiled models were constructed in a 2 x 0.68 x 0.68-meter Metal Free Model Tank (MF-MT). Resistivity data was collected by using an electrode set composed of 50 electrodes interspaced by 4 cm, the electrodes were fixed on a plastic sheet. Wenner-Shlumberger array was chosen to be used in resistivity data acquisition. The ERT experimental modelling results was testified by a numerical simulation of the model. Ground penetrating radar profiles were collected using a 400 MHz antenna in electromagnetically isolated environment, this isolation was assured by the construction of a faraday cage hosting the metal free model tank. Experimental modelling studies have been widely used in geophysical researches in order to have better understanding of the subsurface responses to the applied methods (Yang et al 2019, Wang et al 2010, Sentenac and Zielinski 2009). Electrical resistivity and Ground penetrating radar takes a place among the most prospecting techniques applicable to ground water. The use of geophysical techniques in such kind of researches permit to save time and money while they don't require any excavation and drilling processes. This study aims to experimentally describe the response of an aquifer in both situations unsaturated and saturated.

Material and methods. To reach the goal of the study an unconfined aquifer was simulated using a sand unit placed in the bottom of the tank in order to give a syncline shape to the aquifer, this layer was covered by nylon which plays the role of an impermeable bedrock preventing the water to infiltrate to lower units. The aquiferous unit was represented by high porosity gravel covered by a sandy layer. Results obtained from both applied methods showed significant accuracy in the response to both models.

Results and discussion. ERT measurement showed representative results of the unsaturated model by showing high resistivity values reflecting the nylon bed and the porous zone contrarily to the sandy layer which showed lower resistivity values. Experimental results are in conformity with the numerical modeling results. After injecting the solution, the saturated zone was clearly reflected by the diminution of the resistivity in the middle part of the profile similarly to the numerical model.GPR profiles showed reflections located in the middle parts corresponding to difference of the dielectric constant between sand and gravel. After that the solution was injected to the aquifer the saturated aquifer showed high reflection comparing to the unsaturated one.

Conclusion. The results showed the efficacy of the methods in determining aquifers. The electrical resistivity tomography profiles showed the direct affectation of the anomalies by the degree of saturation of the aquifer. Numerical modeling was a useful tool for testifying the experimentation results. GPR method could be a useful method for verifying the ERT results as it was proven in this study. GPR results reflected almost the perfect structure of the model which makes this method a useful verification method in field studies.

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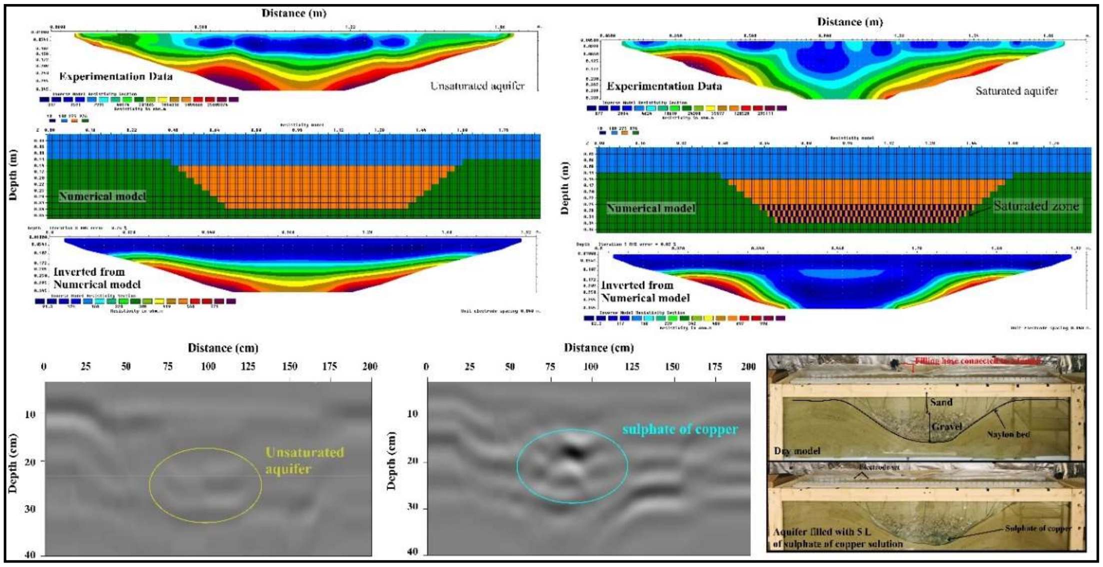

Figure.GPR profile generated for an unsaturated aquifer model.

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