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Deep geoelectrical cross-hole for the hydraulic characterization of an aquifer

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The main problem of a real heterogeneous aquifer is its characterization which is usually obtained from the pumping tests and the relative measurements of the induced drawdown. Unfortunately, these methods are time and cost expensive. Therefore, the use of a hydrogeophysical approach is able to obtain a great deal of information of the aquifer at low cost (Straface et al., 2007).
The target of this work is the determination of hydraulic conductivity spatial distribution in a real heterogeneous porous aquifer analyzing geoelectrical data obtained using an electrical resistivity tomography of the type "cross-hole".
The geophysical techniques more used in hydrogeological studies are geoelectrical methods because electrical resistivity is very sensitive to the water content. In order to determine the hydraulic conductivity spatial distribution, electrical resistivity measurements have been analyzed by two algorithms: Archie's law (1942) and Purvance & Andricevic law (2000).
In this work we propose an experiment, realized in a test site of Soil Conservation Department of University of Calabria located near the town of Montalto Uffugo (Cosenza, Italy). The test site extends on a total area of 2100 m2 and is composed by two aquifers: one phreatic, that extends from the ground surface to a depth of $\sim$7 m, and the other confined between two clay layers, thick $\sim$40 m (main aquifer). The two aquifers are monitored by 11 piezometers. In May 2009 two new piezometers have been installed reaching a depth of 55m. In order to carried out geoelectrical measurements in a cross-hole configuration, 24 steel electrodes have been applied to each piezometers. They are placed with an electrode spacing of 2 m, from a depth of - 6 m to -52 m.
To perform the ERT cross-hole deep $\sim$50 m, has been used the electrode array reciprocal Dipole-Dipole, with energization in both boreholes. The cross-hole electrical resistivity tomography (ERT) allowed us to characterize with more detail the electrical resistivity distribution in subsoil, than geoelectrical investigations from electrodes located on the surface, infact has been found a good correlation between the resistivity distribution and the geological-stratigrafic informations coming from boreholes data (Troisi et al., 2000). Then, the resistivity data were elaborated to characterize the hydraulic conductivity distribution of main aquifer. Successively, in order to 1) compare the electrical resistivity obtained by means of the ERT cross-hole campaign with the electrical resistivity measured in the wellbore and 2) to validate the Archie's law and the Purvance & Andricevic method we have carried out in laboratory, on the core samples of the two boreholes, electrical resistivity and hydraulic conductivity measurements.