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Flowmeter and Ground Penetrating Radar: comparison between hydrogeological and geophysical methods

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A comparison between saturated hydraulic conductivity calculated with Electromagnetic Borehole Flowmeter (EBF) and water content obtained by Ground Penetrating Radar (GPR) Zero Offset Profile (ZOP) is presented. EBF technique permits to obtain permeability profiles along one borehole in the saturated zone by using the Moltz (1993) method. The analysis of ZOP data provides information about the water content (Topp, 1980) in the section between two adjacent boreholes. Water content profiles in the saturated zone can be related to the porosity of the medium which, together with the permeability from EBF measurements, is fundamental for any hydrogeological characterization.

These two methods have been applied to three different test-sites located in the Northern Italy. A first site regards a complex aquifer, characterized by a chaotic sequence of gypsum-marls. The other two sites are characterized by an alternation of sandy and silty-sandy layers. For each site, we adopted the EBF along screened boreholes with 0.25 m spacing, under ambient and stressed conditions. The cross-hole georadar survey was performed within the saturated zone by using 100 Hz borehole antennas with 0.25 m spacing.

The results from the analysis of EBF and ZOP profiles show a general positive correlation between permeability and water content and porosity. This is reasonable for granular soils where the permeability is controlled by the pore space available for water flow, i.e. the effective porosity. For this soils, where EBF permeability and ZOP water-content profiles are in good agreement, the volume between the boreholes can be supposed to be homogeneous. On the other hand, a poor correlation suggests the presence of heterogeneity between the boreholes, which can be observed because the two techniques involve different volumes of soil: the EBF permeability refers to a portion of volume just around the borehole while the ZOP investigates the entire volume between the two boreholes. The poor correlation could be enhanced when enlarging the borehole separation, because the difference in the involved volume between the two techniques increases. Finally, the degree of correlation between the EBF permeability profile and the ZOP water content profile can indicate how much the volume investigated by EBF is effectively representative of the entire volume between the boreholes.

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