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Aquifer characterization using geoelectrical modelling, a case study

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Surface geophysical investigations offer inexpensive and complementary information for hydrogeological issues. The quality and feasibility of geophysical models can be improved considerably by incorporating geological and hydrogeological a-priori information.

In the presented study, densely spaced surface geoelectrical measurements were performed at the hydrogeological testsite Stegemühle, Göttingen, Germany. Twelve parallel profiles, 100 m long, with an electrode spacing of 0.5 m were measured using the averaged half Wenner configuration. The study area consists of a gravel-sand partially confined aquifer. Thanks to former studies a good hydraulic and geological data base is available.

Vertical electrical soundings (VES) as well as 2D and 3D inversions were carried out with the purpose of building a subsurface resistivity model of the aquifer. Commercial software (res2/3Dinv) as well as non-commercial inversion algorithms (VES4, AC2DSIRT) are applied for data analysis. The interpretation of geoelectrical models generally suffers an ambiguity due to the principle of equivalence that hinders the independent determination of layer resistivity and thickness. To overcome this problem, information from certain borehole profiles and conductivity logs were included to calibrate VES and constrain AC2DSIRT modelling. Inversions using AC2DSIRT with an initial model according to the calibrated results of VES generate a 2D resistivity distribution that is significantly more feasible in terms of root mean square and geological data than those without any constraints.

Apart from this, a field specific linear relationship between electrical resistivity and hydraulic conductivity is determined at six well locations. This relation is used to extrapolate the hydraulic conductivity distribution over the whole study area.

In conclusion, the presented field study shows the importance of integration of a-priori geological and hydrological information to improve the output of geoelectrical inversions and to minimize the ambiguity in data interpretation. The derived relationship of electrical and hydraulic parameters serves as a suitable way for a reliable aquifer characterization.