Time-lapse Cross-Hole Electrical Resistivity Tomography (CHERT) for Monitoring Seawater Intrusion Dynamics in a Mediterranean Aquifer

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ABSTRACT

The Argentona site penetrates an alluvial aquifer located at the mouth of the "Riera d'Argentona", an ephemeral stream located along the coast of the Mediterranean Sea, some 40 km NE of Barcelona, in Spain. Permanent monitoring capabilities have been set up at the site to characterize seawater intrusion dynamics. These include electrode arrays along the annular space between casing and soil of 7 boreholes used to perform geophysical electrical resistivity measurements. The electrode spacing was chosen to maximize the quantity of electrodes for each borehole (i.e. to have 36 electrodes in boreholes of 25 m, 20 m and 15 m depth) with borehole distances varying between 10 m and 20 m. The aquifer consists of sandy gravels in two units that are loosely separated by a thin silt layer of only a few decimeters thickness located 9 meters below sea level. In order to study the dynamics of the site, a series of cross-hole electrical resistivity tomography (CHERT) acquisitions were carried out periodically during two years after the site was installed in July 2015 (5 in 2015, 8 in 2016 and 3 in 2017). The 16 datasets were inverted using BERT, which builds on pyGIMLi (Generalized Inversion and Modelling Library), a multi-physics geophysical software library (Rücker et al., 2017). A priori information from the site was included in the inversion process, such as topography (accounting for true well elevation above sea level), depth of water table, stratigraphic contacts and expected lower and upper bounds for resistivity values. The results of the time-lapse inversions indicate that the upper aquifer contains freshwater with resistivities of 20-50 Ohm.m and the lower-lying aquifer unit contains saline water with resistivities of less than 5 Ohm.m some meters below the silt layer. The vertical transition zone appears to be gradual and it does not coincide with the silt layer position. Using the 2-years of monitoring using CHERT, we relate temporal changes to the dynamics of the saltwater intrusion caused by seasonality and to specific events such as rainfalls and droughts. In periods with low rainfall or droughts, a large conductive anomaly shows in the inversion result, whereas in campaigns done just a few days after heavy rainfall episodes, the resistivity of the aquifer increases and the size of the conductive anomaly

shrinks. The time-lapse ERT data acquired in the Argentona site shows features related to aquifer dynamics in both upper and lower aquifers. The use of this data could lead to a better constrained hydrogeological model that merges typical hydrological field data (heads, concentrations, temperature) and electrical resistivity tomography responses in order to invert for hydraulic conductivities and be able to predict saltwater intrusion behavior given certain climate conditions.

REFERENCES

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