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Electrical Resistivity Tomography to characterize localized freshwater discharge in coastal environment

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North Stradbroke Island, located in the Pacific Ocean about 40 km east of Brisbane in Queensland, Australia, is formed by massive sand dunes of heights up to 229 m. The Island represents a reservoir for vast amounts of groundwater and plays an important role for the regional water supply. Therefore a detailed understanding of its hydrogeological features is of particular interest. In the intertidal zone on the western shores of the island, two localized freshwater springs with 4 m and 6 m in diameter were found. Hydrochemical investigations could not unequivocally identify the source of the freshwater by comparing its chemical properties to adjacent surface water and groundwater features.

This case study presents the application of electrical resistivity tomography (ERT) in order to identify the source of the discharged freshwater and to delineate preferential flow paths in the saturated sand sediments.

Several measurements with in-line arrays switching 48 electrodes as well as square arrays with 96 electrodes were conducted. The results of two- and three-dimensional data inversion were refined and verified implementing additional information. In-lab resistivity measurements on undisturbed samples of the sand sediments from the area under investigation as well as data from drill cores were considered for the refinement of the inversion model. The field work was impeded by the tides and allowed only for short periods for set up and measurement.

A semi-confined aquifer formed by a layer of cemented sand at 7 m to 8 m depth perforated at the location of the springs could be identified. The interpretation of ERT data without considering additional geological and in lab resistivity data did not unambiguously indicate the real geological structure of the subsurface. High conductivities in the saturated sandy sediments lead to low investigation depths. Porosity-conductivity relationships for the loose sediments as well as for the cemented sand layer had to be modified to account for their petrophysical properties.