Geophysical Research Abstracts
Vol. 16, EGU2014-3043, 2014
EGU General Assembly 2014

Application of multiple-point geostatistics on modelling pumping tests and tracer tests in heterogeneous environments with complex geological structures

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In heterogeneous environments with complex geological structures, analysis of pumping and tracer tests is often problematic. Standard interpretation methods do not account for heterogeneity or simulate this heterogeneity introducing empirical zonation of the calibrated parameters or using variogram-based geostatistical techniques that are often not able to describe realistic heterogeneity in complex geological environments where e.g. sedimentary structures, multi-facies deposits, structures with large connectivity or curvi-linear structures can be present. Multiple-point geostatistics aims to overcome the limitations of the variogram and can be applied in different research domains to simulate heterogeneity in complex environments. In this project, multiple-point geostatistics is applied to the interpretation of pumping tests and a tracer test in an actual case of a sandy heterogeneous aquifer. This study allows to deduce the main advantages and disadvantages of this technique compared to variogram-based techniques for interpretation of pumping tests and tracer tests.

A pumping test and a tracer test were performed in the same sandbar deposit consisting of cross-bedded units composed of materials with different grain sizes and hydraulic conductivities. The pumping test and the tracer test are analyzed with a local 3D groundwater model in which fine-scale sedimentary heterogeneity is modelled using multiple-point geostatistics. To reduce CPU and RAM requirements of the multiple-point geostatistical simulation steps, edge properties indicating the presence of irregularly-shaped surfaces are directly simulated. Results show that for the pumping test as well as for the tracer test, incorporating heterogeneity results in a better fit between observed and calculated drawdowns/concentrations. The improvement of the fit is however not as large as expected. In this paper, the reasons for these somewhat unsatisfactory results are explored and recommendations for future applications of multiple-point geostatistics on pumping tests and tracer tests are formulated.