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Are single-well "push-pull" tests suitable tracer methods for aquifer characterization?

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Recently, investigations were conducted for geological and hydrogeological characterisation of the sedimentary coastal basin of Horonobe (Hokkaido, Japan). Coastal areas are typical geological settings in Japan, which are less tectonically active than the mountain ranges. In Asia, and especially in Japan, these areas are often densely populated. Therefore, it is important to investigate the behaviour of solutes in such unconsolidated aquifers. In such settings sometimes only single boreholes or groundwater monitoring wells are available for aquifer testing for various reasons, e.g. depths of more than 100 m below ground level and slow groundwater velocities due to density driven flow. A standard tracer test with several involved groundwater monitoring wells is generally very difficult or even not possible at these depths.

One of the most important questions in our project was how we can obtain information about chemical and hydraulic properties in such aquifers. Is it possible to characterize solute transport behaviour parameters with only one available groundwater monitoring well or borehole?

A so-called "push-pull" test may be one suitable method for aquifer testing with only one available access point. In a push-pull test a known amount of several solutes including a conservative tracer is injected into the aquifer ("push") and afterwards extracted ("pull"). The measured breakthrough curve during the pumping back phase can then be analysed. This method has already been used previously with various aims, also in the recent project (e.g. Hebig et al. 2011, Zeilfelder et al. 2012). However, different test setups produced different tracer breakthrough curves. As no systematic evaluation of this aquifer tracer test method was done so far, nothing is known about its repeatability. Does the injection and extraction rate influence the shape of the breakthrough curve? Which role plays the often applied "chaser", which is used to push the test solution out from the borehole and gravel pack? How does density difference between the original groundwater and the test solution influence the tracer breakthrough curves?

To solve these questions, seven push-pull tests were performed under controlled boundary conditions in the same well DD-2 (100 m depth). Only single parameters, as e.g. flow rate or salinization of the test solution, were varied during the experiments.

By conducting these different test setups, conclusions could be drawn about the application of the push-pull method under different settings.

References:

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