



## **Study of the effects of the chaser in push–pull tracer tests by using temporal moment analysis**

Klaus Hebig (1), Sarah Zeilfelder (1), Narimitsu Ito (2), Isao Machida (3), Atsunao Marui (3), and Traugott Scheytt (1)

(1) Technische Universität Berlin, Applied Geosciences, Hydrogeology Research Group, Berlin, Germany (klaus.hebig-schubert@tu-berlin.de), (2) NEWJEC Inc., 1-12-13 Shin-Ohashi, Koto-ku, 135-0007, Tokyo, Japan, (3) Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, Chuo 7, 1-1-1 Higashi, Tsukuba-shi, 305-8567, Ibaraki, Japan

“Push–pull” tracer tests are a suitable tracer test method for hydrochemical characterization of an aquifer in a single-well setting (e.g. in deep geothermal systems). A known amount of selected solutes as conservative and reactive tracers is injected into the aquifer (“push”) and afterwards extracted (“pull”).

In many cases, a so-called “chaser”, which is just original groundwater without any added solutes, is injected directly after the injection of the test solution. Its objective is to push the test solution out of the bore-hole into the aquifer and therefore to minimize the influence of the gravel pack on the shape of the breakthrough curve. The influence of the chaser on the tracer breakthrough curve is unknown so far. Also, the determination of the appropriate volume for the chaser is a difficult task if at all applied.

A first experiment was conducted with the objective to compare three push–pull tests with similar injection volumes, two tests with and one without a chaser. Results show that the application of a chaser lowers the main peak concentration. However, it does not alter the tailing of the breakthrough curve nor does it have a negative influence on tracer mass recovery.

In a second experiment, a new method was developed to determine the optimal chaser volume by testing seven different chaser injection volumes combined with temporal moment analysis and comparison of the mean residence times of the injected tracer fluid.

As a result, the application of a chaser is recommended, when reactions of injected solutes within the open well or the gravel pack should be avoided. If a chaser is used, the new method mentioned above can easily be used to determine the required chaser injection volume. The experiments were conducted at the Hamasato test site in Horonobe (Hokkaido, Japan).