A-216

Caveats before conducting tracer injection-withdrawal tests at geothermal production wells, and recommendations on tracer slug sizing

BMWK-FKZ-03EE4036E-GFK-Monitor

University of Göttingen, Applied Geoscience Dept., Göttingen, Germany

Artificial tracer signals are one of the most important outcomes of reservoir testing during fluid circulation in a geothermal reservoir operated by production and re-injection wells. This prohibits, as a matter of principle, adding more tracer(s) at production boreholes for the purpose of single-well injection-withdrawal (so-called 'push-pull') testing, inasmuch as the added tracer(s) may impede the (on-site and/or laboratory-instrumental) detection of tracer signals from inter-well circulation tests; notably, impediment may still occur even though tracer species used for single-well testing differ from those used in inter-well tests, especially at *early* detection (*strong dilution*) stages for the latter.

.

Unlike for inter-well circulation tests, where tracer slug sizing is determined by the presumed reservoir size, slug sizing for single-well injection-withdrawal tests is unrelated to reservoir size but is determined, essentially, by the very purpose of the test, i.e., *which near-well hydrogeological parameters* are supposed to become invertible from the measured 'pull' signals, and what extent of *parameter inversion ambiguity* [1] is regarded as acceptable.

.

Tracer slug sizing for single-well push-pull tests should follow the approximate relationship:

.

$\mathbf{M}_{push} = F \times (m \times \mathbf{DL}) \times (p \times \mathbf{V}_{push})$

with factors $m > 10$ and $p > 3$,

where

DL is the detection limit of the chosen tracer species in the reservoir fluid,

$\mathbf{V}_{push}$ is the fluid chaser volume,

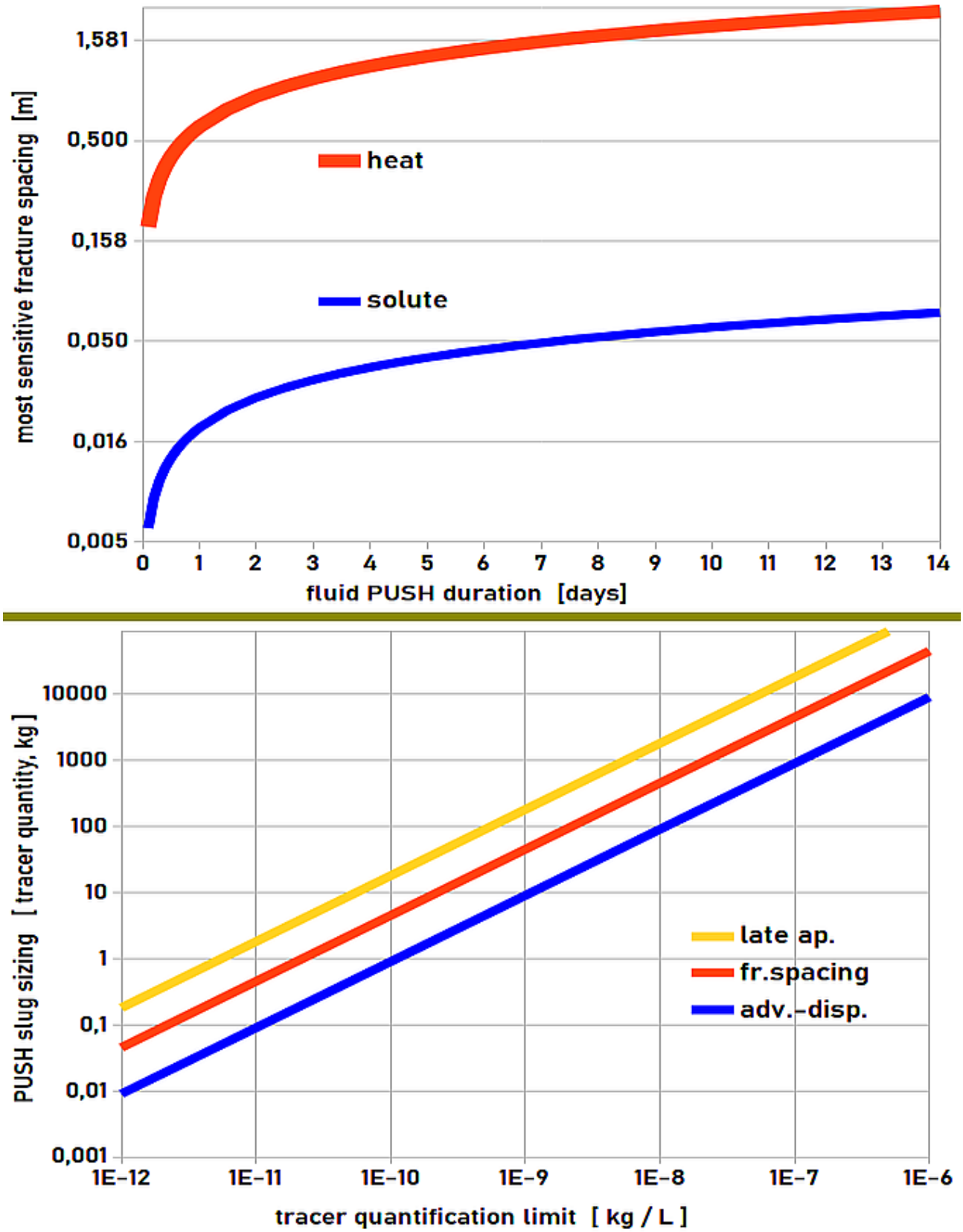
$\mathbf{M}_{push}$ being the quantity of artificial tracer to be added (**mass** of solute chemical compound, or **activity** of a suitable radionuclide which must, in turn, be input in water-soluble and chemically suitable speciation; chemical 'adequacy' being meant particularly in terms of adsorption-desorption behaviour at the adjacent rock material or, more generally, of so-called 'water-rock interactions').

.

We expect $F > 6$ to enable the inversion of advective parameters (transport-effective porosity, dispersivity), $F > 20$ to further enable the inversion of fracture apertures, $F > 300$ to yet further enable the inversion of long-term asymptotic fluid-rock interface area density.

.

We discuss pro's and con's of keeping F as low as possible, and illustrate the proposed approach for a particular production well belonging to a geothermal borehole sextet (three production, three re-injection wells) in a 4-5 km deep, porous-fractured-karstified Malm aquifer in the Alpine foreland, beneath the Munich area.



The transport parameter sensitivity of heat or solute tracer ‘pull’ signals depends on ‘push’ slug sizing

References:

[1] Ghergut J, Behrens H, Sauter M, (2013), Single-well tracer push-pull test sensitivity to fracture aperture and spacing, Stanford Geothermal Procs, SGP-TR-198, 295–308, https://sites.google.com/view/publist-att-ig