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Flow regime mapping: outcome, or pre-requisite of tracer tests? (from the standpoint of deep-georeservoir characterization, development, operation, and monitoring)

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Tracer tests in deep-subsurface flow usually yield fluid residence time distributions (RTD) for a sparse selection of fluid spiking and fluid sampling points. Such RTD can be explained more or less adequately assuming certain flow and transport boundary conditions, and a fractured-porous void-space structure in which advective-dispersive transport and possibly partitioning/reactions at interfaces take place. Yet RTD do not by themselves enable to tell 'where' a flow process is taking place. So to say, "to trace is not to track", and 'tracking' would require some complementary kind of mapping, imaging, or monitoring – additionally to the metering of tracer fluxes at the few accessible 'places' in the georeservoir (i. e., deep boreholes) at which fluids can be sampled. We do not feel the need for such 'tracking' capability, when tracer-based RTD are used to predict the thermal lifetime of, say, a geothermal well doublet. However, the ability to 'locate' flow and transport processes (in both space and time) may become critical when facing environmental impacts of deep-georeservoir operation, and liabilities associated with these. On the other hand, it can also be a primary task in reservoir diagnostics and engineering, for instance when facing the question of whether and where to re-frac (in unconventional reservoir development).

The poster describes three paradigm settings where a complementary, non-fluid-borne mapping of flow regimes (or at least of flow regime contrasts) appears as a very sensible, if not indispensable counterpart to tracer-based RTD for predicting (or accounting for) deep-georeservoir behavior. These are illustrated with

(a) inter-well tracings of geothermally exploited Malm aquifers beneath the Munich metropolitan area, in analogy to past work conducted by Seiler et al. (1989) in the Franconian Alb;

(b) single-well spikings of petrothermal or aquifer-based EGS in the N-German sedimentary basin, with two major issues left unresolved by Ghergut et al. (2016);

(c) single-well spikings of multiple-fracture systems for unconventional reservoir development.

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References:

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