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Artificial-tracer techniques applied to georeservoirs: what you (don't) see is what you get?

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'Artificial-tracer technique' (ATT) stands for any means of inferring the properties "... of a system by observing the behavior of [something] added to it" (Gardner and Ely 1967) in a well-defined quantity and manner.

In subsurface flow systems, ATT for practical purposes (like fluid residence time estimation for delineating groundwater protection zones, estimating fluid exchange rates, or ascertaining the relative uncoupling between hydrogeological compartments) require a different mindset than ATT for research purposes (e. g., for developing novel tracer species). One cannot overemphasize it: the proper statement and understanding of an ATT's purpose is crucial to the choice of suitable tracers, the adequate design and dimensioning of tracer additions, of fluid sampling, of tracer signal metering and interpretation, and to the proper handling of ATT-related legal and environmental aspects.

At 'bulk' georeservoir scale, AT signal interpretation benefits from stronger inter- and intra-disciplinary consensus as to its purpose, as well as from certain analogies with some well-established methodology from disciplines using natural tracers (e. g., Zuber and Maloszewski 1980ff). On the other hand, the very notion of a 'bulk' reservoir scale is subject to much controversy (e. g., Leary and Malin 1990ff).

At intermediate inter-well scales, and especially at wellbore scale, AT signal evaluation is rather poorly constrained both in terms of its actual purpose and of its prediction targets, let alone of its underlying models. Experience made with ATT applied in deep tight-rock or mixed-type EGS in the N-German sedimentary basin, and in hydrothermal reservoirs in the S-German molasse basin reveals how the different perception of ATT purposes may lead to a bizarre divergence of opinions between colleagues (else sharing the same upright commitment to their common discipline), even with regard to the set-up and the trimming of laboratory-instrumental techniques for tracer signal metering (a. k. a. 'tracer analytics').

All examples refer to single-phase (liquid-phase) georeservoirs developed in 3 – 5 km depth, with inter-well distances up to 3 km, or single-well screens up to 300 m apart. Part of the work pertaining to tight rock systems was conducted within EU project "FracRisk" (H2020 grant agreement No. 636811), whereas all work pertaining to the S-German molasse basin was conducted within "TRENDS", a project supported by the German Federal Ministry for Economic Affairs and Energy (BMWi grant no. 0325515).