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First-order discontinuity in tracer mass recovery: indicative of (large) induced fracture(s)?

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Forced-gradient flow sustained by a geothermal well doublet in a porous-fissured reservoir (more or less karstified, Jurassic formation, cf. Behrens et al. 2020 for a conceptual-hydrogeologic model outline and competing hypotheses as to what role *large fractures* might play) is subject to a tracer test anew, following a significant augmentation of fluid turnover rates. The distinct aromatic sulfonates (N2S and P4S) used as tracers in the first (lower-rate) and the second (higher-rate) test are supposed to be transported conservatively and similarly under this reservoir's in-situ conditions; in terms of solute diffusivity, the larger molecule size of P4S ought to be roughly matched by N2S's stronger hydratization in-situ, and for assuming else physicochemically conservative behavior one may invoke vast evidence from past applications in mineralogically variate, saline, hot reservoirs (Behrens 1992ff; Rose 1997ff). Cumulative mass recovery for each tracer can be calculated based on its theoretical 'single-passage' signal, deconvolved from its measured signal (eliminating 'redundant' contributions from fluid recirculation; to account for flow-rate variability, we set up an ad-hoc deconvolution algorithm). From tracer sampling to date, CMR amounts to ~28% for P4S, and ~70%* for N2S – whose first 20-30%* mass amounts were swept through the reservoir under the lower-rate flow regime, and its subsequent amounts under the higher-rate regime, reaching 60-65%* by the time P4S was added (for the latter, a certain time lag after flow rate augmenting was allowed, not having in pectore whether the higher flow rate would prove sustainable, and how long it would take for the flow field to reach a new 'quasi-steady' state at reservoir scale; pressure buildup/drawdown changes at injection/production wells stayed uninterpretably low). Those N2S %* cannot be told accurately due to short-term flow-meter (instrumental) failures during precisely this transition. CMR for P4S exhibits a significantly lower growth rate than for N2S (even when plotted against cumulative fluid turnover, which should compensate for flow-rate disparities), and, more strikingly, a marked first-order discontinuity (tangent drop) after reaching ~20% (which would correspond to ~30% N2S after the same cumulative fluid turnover, counted since tracer injection). Three hypotheses which might explain these findings are evaluated: P4S decay? reservoir 'stimulation' -> stronger P4S dilution? reservoir 'compartmenting' -> P4S 'loss' into some 'non-pay' zone? Accordingly, special monitoring options that would allow to disambiguate (or refute) some 'induced fracture' / 'activated fault' / 'karst window' scenarios are discussed. [*Note: not only these particular values for N2S, but its entire subsequent CMR calculation is impeded by the flow-meter data gap; as a substitute, one may attempt to reconstruct the missing flow-rate data from 'geothermal' power generation data, but here operator-provided information is insufficient. For P4S however, being injected way later after

this metering gap, its tangent discontinuity in CMR stays independent upon the missing data] – – **Reference:** SGP-TR-216, pp.195-201, pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2020/Behrens.pdf (for a reservoir model outline, and early tracer signal illustrations)