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Single-well and inter-well spiking design for characterizing potential CO_2 storage sites in deep geologic formations in Germany

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Investigating and evaluating potentially adequate sites for CO_2 capture and sequestration in deep geologic formations usually means to deploy the scientific arsenal of geophysics, geology, hydro-geochemistry, mineralogy, petrology, hydraulics, isotopes and so on. This sometimes leads to the odd consequence that "not enough (work energy or time) is left for" conducting tracer tests in the formation under investigation (albeit tracer tests are indispensable in almost any basic hydrogeological issue, i.e. as soon as *fluid-based transport or storage* are of concern). Also, a majority of scientists seems to agree in the belief that (alongside with a handful of natural, mostly isotopic, geo-tracers) spiking the injected CO_2 itself, "would do" as for all that needs to be done "in terms of tracers".

However, once CO_2 was injected into a geologic formation in more than negligible amounts and there is some measurable signal of anything 'transportable' at all wanting to be *interpreted* : *fluid-based transport* processes in the system (their absence, or the degree of their action) will be a *necessary part of the interpretation*; but they will be difficult to interpret and quantify (unambiguously) in the presence of injected CO_2, if the transport properties of the system failed to be determined *prior to* the CO_2 injection; and the natural geo-tracers would not compensate this gap.

As a matter of fact, tracer tests (artificial spikings) are not always easy and inexpensive to conduct, especially in deeper geologic formations and over the required long time periods; nor can their interpretation be freed from all ambiguity. Nevertheless, they remain the only method for determining fluid residence times (in other words, the

effective *size* of a reservoir under given hydraulic conditions) and for characterizing the interface between water and rock in terms of solute exchange fluxes traversing it. For this reason they should be allotted no less ‘working energy’ than any other scientific investigation method from the prae-CCS site characterization arsenal.

For two CCS candidate formations, examples of single-well and inter-well spiking design are presented in which the flow rate and duration constraints of already planned hydraulic operations are taken as a datum, with just minimal additional injections/withdrawals for the spikings themselves; the sensitivity of tracer signals w. r. to transport parameters of the formation is analysed under these conditions.

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