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Brine-phase spikings in CCS-candidate formations: are they useful? (an example from the Ketzin site in Germany, 2008)

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The transport-reaction equations governing the fate of CO2 injected into a geological formation contain a «transport-effective porosity» essentially as a scaling factor for the time variable, and a «fluid-rock contact-surface density» as a coefficient factor in several of their reaction and solute exchange flux terms.

The first of these parameters, the «transport-effective porosity» is vital to any CCS enterprise, in that it determines the storage capacity of the target formation, in other words the residence time of injected CO2 or 'how fast it will move from A to B' under given injection rates.

The importance of the second parameter «fluid-rock contact-surface density» may vary depending on geologic, hydrogeochemical and geotechnical details of the intended CCS site operation and fluid conditioning before injection.

Ideally, water-phase spikings (tracer tests) in inter-well as well as single-well arrangements prior to CCS operation would provide the method of choice for determining both parameters. However, such tests can be conducted only at limited space and time scales prior to CCS operation; the values of their target parameters may change due to various THMC processes; and, last not least, the 'effective' values of their target parameters may be phase-dependent. Thus, transport characteristics of a CCS-candidate geological formation, as derived from brine-phase spikings will not suffice to fully describe the long-term CCS behavior (CO2 transport and storage properties) of the target formation.

Since, by virtue of lower density and viscosity, injected CO2 will largely flow ahead of native brines, i.e. the brine phase will not be displaced by injected CO2 like in 'piston-flow' systems but will diverge vertically and become strongly 'retarded' against the CO2 phase, a water-phase tracer injected together with CO2 (i.e., a water-phase spiking during CCS) can hardly fulfil an early-warning function within CCS monitoring. On the other hand, fingering effects for both phases and overenhanced fluid-to-rock fluxes for the CO2 phase might act in the opposite sense, effecting some retardation on the CO2 phase. But still, generally, pre-existing preferential flow pathes will tend to become overenhanced for the lower-density / lower-viscosity phase; thus, native brine motion (and any water-phase tracer put into them) will probably remain retarded along the major CO2 flow directions, for most of the time.

The brine-phase spiking initiated alongside with CO2 injection at the Ketzin site in Germany as of mid 2008 provides (with all of its unorthodox features) a good opportunity for re-assessing the scope and limitations of water-phase tracers' expressivity with regard to CCS.

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