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Laboratory and numerical investigations of kinetic interface sensitive tracers transport for immiscible two-phase flow porous media systems

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A number of theoretical approaches estimating the interfacial area between two fluid phases are available (Schaffer et al.,2013). Kinetic interface sensitive (KIS) tracers are used to describe the evolution of fluid-fluid interfaces advancing in two phase porous media systems (Tatomir et al., 2015). Initially developed to offer answers about the supercritical (sc)CO_2 plume movement and the efficiency of trapping in geological carbon storage reservoirs, KIS tracers are tested in dynamic controlled laboratory conditions. N-octane and water, analogue to a scCO_2 – brine system, are used. The KIS tracer is dissolved in n-octane, which is injected as the non-wetting phase in a fully water saturated porous media column. The porous system is made up of spherical glass beads with sizes of 100-250 μm. Subsequently, the KIS tracer follows a hydrolysis reaction over the n-octane – water interface resulting in an acid and phenol which are both water soluble. The fluid-fluid interfacial area is described numerically with the help of constitutive-relationships derived from the Brooks-Corey model. The specific interfacial area is determined numerically from pore scale calculations, or from different literature sources making use of pore network model calculations (Joekar-Niasar et al., 2008).
This research describes the design of the laboratory setup and compares the break-through curves obtained with the forward model and in the laboratory experiment. Furthermore, first results are shown in the attempt to validate the immiscible two phase flow reactive transport numerical model with dynamic laboratory column experiments.

Keywords: Fluid-fluid interfacial area, KIS tracers, model validation, CCS, geological storage of CO_2