3D Observations of Reactive Transport in Natural Consolidated Rocks

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Rock structure heterogeneity can have a significant effect on dispersion, mixing and reaction of aqueous components in porous media. To observe the effect of pore structure heterogeneity on reactive transport, core flooding experiments were carried out for a sandstone and two carbonate rocks of different heterogeneity for eight different Peclet numbers ranging from 0.5 to 100. The rock cores were 20cm long and had a diameter of 7.62cm. A device consisting of three annular regions was used for injection (fig.1). Water was injected into the centre and outer region and a chemical tracer into the middle region. A non-reactive NaI tracer was used for the transport experiments. The steady state transverse dispersal of the tracer was visualized in three dimensions with an X-ray medical CT-scanner (fig.2). Core averaged transverse dispersion coefficients were calculated and showed an increase with pore structure heterogeneity. Concentration maps were used to visualize heterogeneity and quantify larger scale flow structures e.g. meandering, flow focusing, flow splitting by using observations at different Peclet numbers (fig.3). For the reactive experiments an acidic tracer was used resulting in mineral dissolution. An ICP-MS was used to measure the effluent. The reactive core flooding experiments were modelled using the CrunchFlow reactive transport code. For this purpose, the results of the transport experiments were used in combination with available pdf's of reactive surface area for the different rocks. High quality data sets of the space and time evolution of the concentration in core-flooding experiments like these can be used as future benchmark test for numerical models for reactive transport in natural rocks.

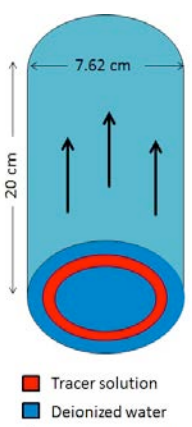

Fig. 1. Inlet configuration during core-flood experiments

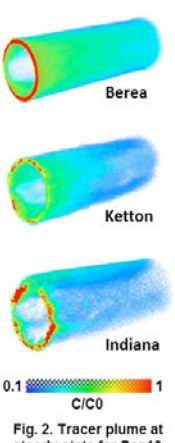

Fig. 2. Tracer plume at steady state for Pe=10

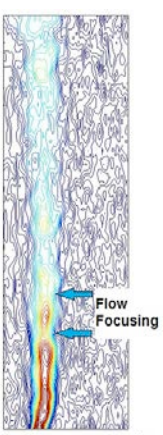

Fig. 3. Iso-concentration contour for radial transect of Berea (Pe=2)