3D observations of reactive transport in heterogeneous rocks

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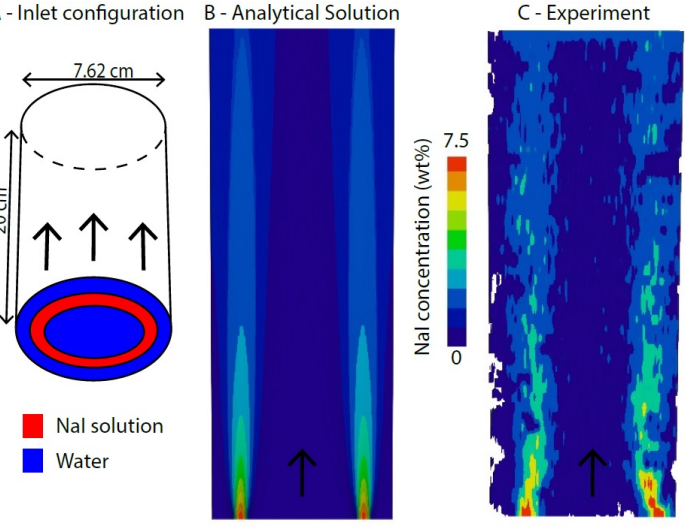
Rock matrix dissolution, mineral precipitation and inter-fluid mass transfer will have an important impact on reservoir quality and storage integrity during the injection of CO_2 into carbonate reservoirs. Rock structure heterogeneity can have a significant effect on processes involving transport and reaction of aqueous components through 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 four different peclet numbers. The rock cores were 20cm long and had a diameter of 7.62cm. The dispersion, mixing and reaction of chemical components were visualised in 3D with the use of chemical dopants and a medical CT scanner (fig. 1C). Heterogeneity is characterized by the spread in local transverse dispersion coefficients. For Peclet number 2, for the homogenous rock the local transverse dispersion coefficients ranged from 4.1x10-4 cm2 min-1 to 5.9x10-4 cm2 min-1 and for the most heterogeneous rock from 2.5x10-3 cm2 min-1 to 7.2x10-3. A device consisting out of three annular regions was used for injection (fig. 1A). An analytical solution to the flow and transport equations for this new inlet configuration was derived to design the experiments (fig. 1B). For the reactive transport experiments, an ICP-MS was used to measure the effluent. The core flooding experiments were modelled using both, the CrunchFlow and ToughReact reactive transport codes. High quality data sets of the space and time evolution of the concentration in non-reactive and reactive core-flooding experiments like these can be used as future benchmark test for numerical models. Furthermore, these observations can be used in the development of upscaling techniques for accurate and efficient modelling of chemical processes during flow in porous media.



1-A. Inlet configuration during experiments. B. Analytical result for Ketton bonate rock for Pe=2. C. Experimental result for Ketton carbonate rock for Pe=