The effect of density-driven flow in the through-diffusion experiment

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Intercrystalline fluid can significantly affect rheological properties of rocks via pressure solution creep, fluid-assisted recrystallization, etc., and the diffusion coefficient through the intercrystalline fluid is thought to be one of the most important rate-determining parameters. The effective diffusion coefficients of dissolved ions in rocks are usually measured by the through-diffusion experiment. However, in this experiment, the effect by advection, caused by density difference between dense electrolyte solution and pure water, has not been considered. The presence of this advection might result in the large apparent value of the diffusion coefficient. Therefore, we performed the through-diffusion experiments using Fontainebleau sandstone sample to elucidate the effect of density-driven flow by using both the experimental results and theoretical modeling of the combination of Darcy's law and diffusion-advection equation. As a result, the apparent effective diffusion coefficient was about one order larger for KI 1M (density difference, 0.116g/cm3) than that for KCl 0.1M(0.005 g/cm3). Thus, the through-diffusion experiment under the conditions of high density of the tracer solution and high permeability of the sample can lead to the overestimation of the effective diffusion coefficient.