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Spatial dispersion vs experimental uncertainties of diffusive parameters in hard clay rocks

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Due to extreme hydraulic and retention properties, indurate clay rocks are considered worldwide as potential host rocks for radioactive waste disposal. Numerous studies have shown that migration of nuclides is in argillaceous rocks mainly controlled by diffusion. The reliability of the value of diffusion parameters (e.g. effective diffusion coefficient and accessible porosity) is thus fundamental and of major concern: the inherent uncertainty due to the extrapolation from lab experiments at cm scale to field experiments has thus to be properly evaluated. In this context, the question to answer is: what is an appropriated rock volume for diffusion experiments for being used in safety case calculations?

In this study, we addressed this question in three steps. We first estimated the experimental uncertainties of water diffusive parameters obtained by classical through-diffusion experiments at a centimetre-scale using two different statistical methods: the first one is a Gaussian error propagation formula whereas the second one is based on a Monte-Carlo approach. Then, spatial dispersion of the water diffusive parameters was obtained on several rock samples taken from the same core (core length < 15cm). The confrontation of the experimental uncertainty and spatial dispersion allowed us to define the range of diffusive parameters and ultimately constrain the representative elementary rock volume for diffusion.

Mineralogical and textural heterogeneities observed at the centimeter scale are thought to cause spatial dispersion exceeding the experimental uncertainty. This approach was applied to two different argillaceous rocks with distinct textures and mineralogy.