

Effect of radiation-induced amorphization on smectite dissolution kinetics

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In the high level nuclear radioactive waste repositories (HLNWR) management, smectite (a major constituent of bentonite) is considered to limit the dissemination of radionuclide in the environment¹. Indeed, smectite exhibits interesting properties such as a high cation exchange capacity and swelling capacity that are expected to enhance the retention of radionuclides in a case of a leakage of the waste. For this reason, in France, smectite will be found in the near and far field of the waste. In the near field of the waste, bentonite will be a major constituent of the engineering barriers used mainly for backfilling and in the far field, deep argillaceous formations are the expected host rock.

However, it was recently reported that the conditions for induced amorphization of smectite by heavy ions were consistent with a leakage scenario in a HLNWR². Such amorphization is expected to induce strong modifications of the mineral properties such as sorption capacity, swelling and dissolution kinetics. In this study, we used a purified smectite issued from the MX80 bentonite in order to evaluate the influence of amorphization on the dissolution kinetics.

The sample was irradiated with 925 MeV xenon ions at the GANIL facility (Caen, France). Amorphization was controlled by X-ray diffraction, transmission electron microscopy and Fourier transform infrared spectroscopy. Besides, an important coalescence of the smectite sheets was observed by scanning electron microscopy, which lead to a loss of interparticle porosity. Furthermore, it was observed that the dissolution rate far-from-equilibrium is two times larger in the amorphous sample than in the reference clay. We will discuss the result with previous observations on other minerals and the potential implications for the dissemination of radionuclides in the environment.