Impact of temperature on mechanical and geochemical behaviour of swelling clay minerals

Roy Chaaya, Stéphane Gaboreau, Hugues Raimbourg, Joachim Tremosa

Impact of temperature on mechanical and geochemical behaviour of swelling clay minerals.

Roy Chaaya[1,2]*, Stéphane Gaboreau[1], Hugues Raimbourg[2], Joachim Tremosa[1]

[1]BRGM, 45060 Orléans, France.
[2]ISTO, UMR 7327 – Université d'Orléans, CNRS, BRGM, 45071 Orléans, France.

* r.chaaya@brgm.fr

The ubiquity of swelling clay minerals in surface and sub-surface geoscience systems, in sedimentary deposits, in fault zones or in their potential application in the context of nuclear waste disposal make the effect of temperature (≥ 60°C) on their hydrological, mineralogical and mechanical behaviour a major scientific issue. Therefore, we aim to assess the swelling behaviour of clays when hydrated at temperature (≥ 60°C) under confined conditions. The swelling results from water-mineral interactions at different scales, from interlayer space within crystallite to pore space between particles, depending on the charge compensating cations. We are tackling these physical and chemical issues using a combined approach of experiments and geochemical modelling in order to apprehend the osmotic and crystalline contributions. Swelling experiments were performed with homo-ionic clays with different solutes (cations and ionic strength) and at different dry densities from 1.4 to 1.6 $g.cm^{-3}$. Preliminary results acquired at temperatures ranging from 25 to 80°C show that swelling pressure of compacted Kunipia-Na form at a density of 1.4 $g.\ cm^{-3}$ decreases by 33% at 80°C (figure 1). This temperature effect seems to become less significant with increasing density (i.e. 24% for d=1.6 $g.cm^{-3}$). On the contrary, the swelling pressure of Kunipia-Ca remains almost constant showing a very negligible effect of temperature on Ca-form smectites. On the other hand, X-ray diffraction analysis performed on sodium and calcium smectite powders under controlled relative humidity at temperatures of 25°C and 80°C show that the temperature has a very negligible effect on the interlayer water retention capacity and thus on the crystalline component of the swelling pressure (figure 2). Complementary data of water adsorption gravimetry isotherms, in confined conditions, were obtained in the same conditions. This set of data will thus allow to assess the temperature effect on both crystalline and osmotic water retention capacity.

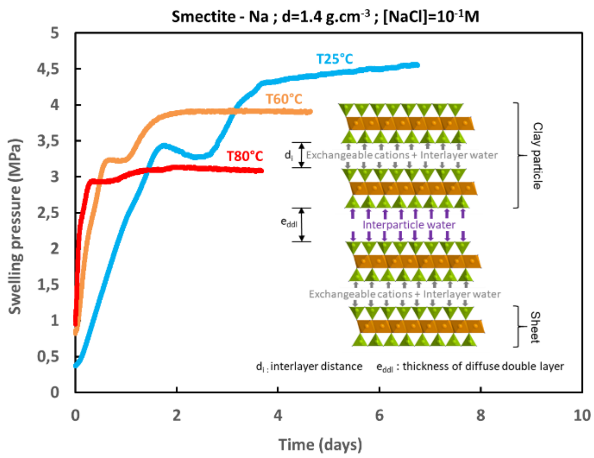

Figure 1: The swelling test results of a Kunipia-Na of density 1.4 $g.cm^{-3}$ hydrated by a NaCl solution of concentration 10^{-1}M at temperatures of 25; 60 and 80°C.

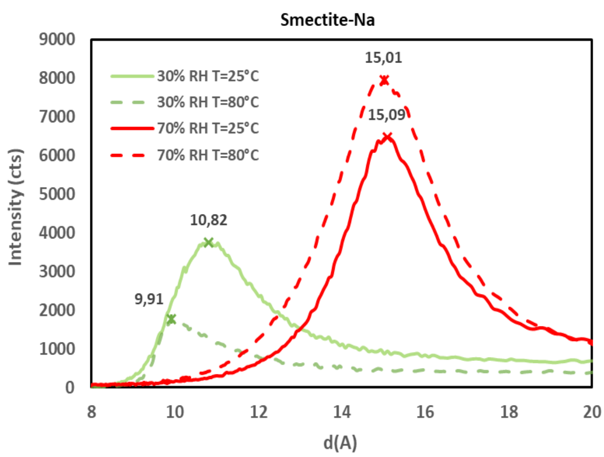

Figure 2: Recorded basal distances of Kunipia-Na at temperatures of 25°C and 80°C for relative humidities of 30% and 80% (XRD).

Preferred format: Oral

Session 19 : High temperature impact on bentonite barrier systems in the context of radioactive waste disposal.