



**HAL**  
open science

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

Roy Chaaya, Stéphane Gaboreau, Hugues Raimbourg, Joachim Tremosa

► **To cite this version:**

Roy Chaaya, Stéphane Gaboreau, Hugues Raimbourg, Joachim Tremosa. Impact of temperature on mechanical and geochemical behaviour of swelling clay minerals. AIPEA – XVII INTERNATIONAL CLAY CONFERENCE (ICC 2022), Jul 2022, Istanbul, Turkey. hal-03682673

**HAL Id: hal-03682673**

**<https://brgm.hal.science/hal-03682673v1>**

Submitted on 31 May 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

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

Roy Chaaya<sup>1,2\*</sup>, Stéphane Gaboreau<sup>1</sup>, Hugues Raimbourg<sup>2</sup>, Joachim Tremosa<sup>1</sup>

<sup>1</sup>BRGM, 45060 Orléans, France.

<sup>2</sup>ISTO, UMR 7327 – Université d'Orléans, CNRS, BRGM, 45071 Orléans, France.

\* [r.chaaya@brgm.fr](mailto: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 ( $\geq 60^\circ\text{C}$ ) 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 ( $\geq 60^\circ\text{C}$ ) 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  $\text{g}\cdot\text{cm}^{-3}$ . 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  $\text{g}\cdot\text{cm}^{-3}$  decreases by 33% at 80°C (figure 1). This temperature effect seems to become less significant with increasing density (i.e. 24% for  $d=1.6\text{ g}\cdot\text{cm}^{-3}$ ). 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.

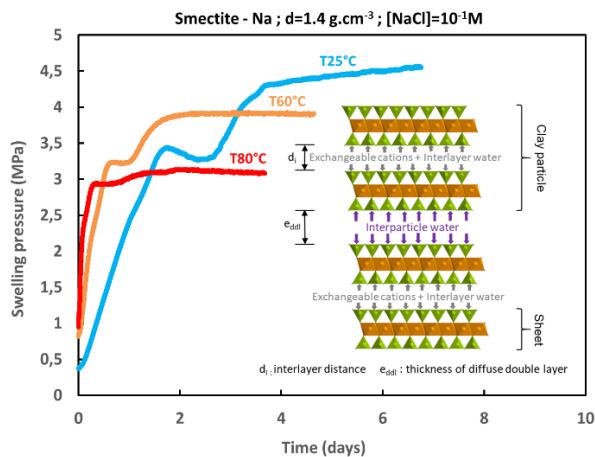


Figure 1: The swelling test results of a Kunipia-Na of density 1.4  $\text{g}\cdot\text{cm}^{-3}$  hydrated by a NaCl solution of concentration  $10^{-1}\text{M}$  at temperatures of 25; 60 and 80°C.

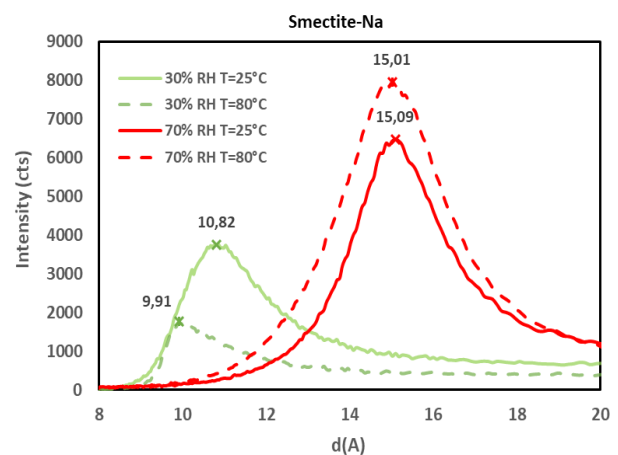


Figure 2: Recorded basal distances of Kunipia-Na at temperatures of 25°C and 80°C for relative humidities of 30% and 80% (XRD).

Preferred format: Oral

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