



## Swelling of Clays : In Situ Neutron Scattering experiments

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Swelling clays are finely divided minerals whose structure consists of negatively charged silicate layers with cations in the interlamellar spaces that compensate the clay layers charge. The particular swelling properties of these mineral results from the hydration ability of these cations. In humid atmosphere water molecules penetrate the interlayer spaces to form hydration spheres around cations and a step by step increase of the interlayer distances is associated with this water uptake.

Key parameters such as nature of interlayer ion, charge amount and localization have been evidenced by numerous techniques but much less is known on the water molecules network that forms during the interlamellar spaces filling. Neutron scattering experiments appear as particularly appropriate to understand the arrangement of interlayer species thanks to the possibility of performing measurements both with H<sub>2</sub>O and D<sub>2</sub>O that differ in contrast. Thus, the combination of experiments with both these isotopes enables to get two different pictures of the same hydration state. This kind of measurements carried out on a synthetic saponite clay with a well-defined charge

clearly showed that the hydration states were homogeneous in terms of interlayer distance, but that for a given spacing, the density and structure of interlayer water was changing significantly with charge. The experimental diffraction patterns were correctly simulated using molecular configurations derived from Grand Canonical Monte Carlo simulations.

In another context, compacted clays are the object of special attention due to their macroscopic properties such as cation retention and low water permeability. This sealing ability makes them particularly appropriate materials for the design of engineered barriers to prevent pollutants migration. The prediction of the buffer barrier behaviour requires a detailed description of the clay fabric as a function of both water content and compaction ratio. As neutrons are weakly absorbed when passing through matter, experiments on large, dense and compacted samples can be easily performed. In addition, the combination of small angle neutron scattering experiments with neutron diffraction allows a continuous description of the clay particles arrangement from the length scale of the interlayer spaces to the submicronic porosity. Preliminary measurements performed on the D16 small momentum transfer diffractometer setup of the Institut Laue-Langevin evidenced the possibility to follow the evolution of interlayer distances through hydration of compacted samples. At high water activity the d-spacing of compacted clays is higher than the one observed on free to swell samples. This result needs to be further analysed in relation with the evolution of the porous network as a function of the compaction degree.