Hydration sequence of swelling clays exchanged with mixed alkali/alkali-earth cations

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Swelling clays can absorb/adsorb a great quantity of water inside the interlayer space and the mesoporosity. This adsorbed quantity of water is strongly dependent on the nature of the interlayer cation. In order to probe the hydration sequence in clays as a function of the relative humidity (RH), XRD measurements, water adsorption and calorimetry, thermoporometry and electrical conductivity results are coupled with electrostatic calculations.

**Aim of this study:** (i) determination of the hydration sequence of swelling clays as a function of the nature of the interlayer cations

(ii) To elucidate the mobility process of the interlayer cations as a function of the hydration state

**Material and Method**

**Experiments**

- Study the “clay-water” system by looking at the modifications of water properties
  - “water inside clays” is different from liquid water (or free water)

- Thermoporometry = calorimetric technique sensitive to phase transitions of fluid confined in the porosity
  - 2 nm < Pore radius < 50 nm (mesoporosity)

- Originality of these experiments: investigation of swelling material & various RH

**Results and Interpretation**

- Comprehensive determination of clay hydration sequence for Na-Ca montmorillonite

- Diffusion coefficients at 29°C

- Evolution of the mobility is impacted by both the interlayer space opening and the hydration status of the extra-framework cation

**Conclusion**

- Sequence of hydration is depending on the interlayer cation nature.
- High mobility/diffusion of the smaller cations confirms the weak interactions existing between the hydrated Li⁺ and Na⁺ compared to the others cations.
- In the case of the mixture Na/Ca cations, Ca²⁺ is hydrated at lower RH than the Na⁺ cation as confirmed by adsorption calorimetry.