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OPALINUS CLAYSTONE - LOW ALKALI (LAC) CONCRETE INTERACTION: MINERALOGICAL INVESTIGATIONS AND IDENTIFICATION OF A MG-RICH PHASE

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A five-years-old interface between a low alkali concrete (LAC, CEM III/B containing 66% slag and 10% nano-silica) and Opalinus (OPA) claystone from CI drillhole (Mont Terri Underground Rock Laboratory – Jenni et al., 2014) was studied for its textural properties, mineralogy and chemistry, in order to investigate the alkaline perturbation.

After five years, the reactivity between LAC concrete and Opalinus claystone is found to be limited to a ~1 mm-thick with a porous (~75% porosity) white crust developed on the concrete side. Quantitative mineralogical mapping of the white crust (electron microprobe - EPMA), combined with infrared and Raman spectroscopies on separates of cement matrix, provides evidence for a Mg-rich and phyllosilicate-like phase, which could have talc-like structure (Roosz et al., 2015) accounting for ~25 % of the matrix, associated with the presence of ~11% of calcite. EPMA profiles of Al, Ca, Mg and Si performed through the white crust provide evidence for about homogeneous composition. The chemical formula of the Mg-rich phase was found to be $\text{Ca}_{0.6}\text{Fe}_{0.1}\text{Mg}_{1.6}\text{Al}_{1.2}\text{Si}_{3.45}\text{O}_{10}(\text{OH})_2$ by spot EPMA analyses.

Textural, mineralogical and chemical modifications due to the chemical gradient in the OPA clay at contact with the LAC concrete are limited. Mineralogy of OPA clay remains largely unmodified. The cation exchange capacity (CEC) values measured in OPA clayrocks at contact with the LAC concrete range between 153 and 175 meq kg⁻¹, close to the reference value of 170 ± 10 meq kg⁻¹ (Pearson et al., 2003). The cation occupancies in the CEC change at the interface with LAC cement, marked mainly by an increase of Mg and a decrease of Na. EPMA mapping of major elements in Opalinus claystone side also provided evidence of a Mg-enriched 300-400 µm-thick band. Leaching tests performed on OPA clay with deionised water and at different solid to water ratios strongly suggest that Cl and SO₄ have conservative behaviour, with concentrations measured at 2 cm from the interface being close to concentrations of preserved OPA pore waters (SO₄: 0.45 ± 0.15 mmol 100 g⁻¹; Cl: 0.75 ± 0.21 mmol 100 g⁻¹), and increasing towards the interface with the concrete. The SO₄ to Cl ratios also increase towards the interface, suggesting that the increasing anion concentrations are not related to porosity variations.

References

- [1] Jenni, A., et al., *In situ interaction between different concretes and Opalinus Clay*. Phys. Chem. Earth, 2014. 70–71: p. 71-83.
- [2] Roosz, C., et al., *Crystal structure of magnesium silicate hydrates (M-S-H): The relation with 2:1 Mg-Si phyllosilicates*. Cem. Con. Res 2015. 73: p. 228–237.
- [3] Pearson, J., et al., *Porewater chemistry and geochemical modelling*. p. 67-104 in: Mont Terri Project - Geochemistry of water in the Opalinus Clay Formation at the Mont Terri Rock Laboratory 2003. Geology Series N°5.