Mg uptake and wettability alteration of calcite surfaces

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Calcite is the main mineral in limestone and chalk formations that host many water and oil reservoirs in Europe. Modification and control of calcite surface properties, especially wettability, are relevant for remediation of soil contamination, for enhancing oil recovery (EOR), in industrial applications and for prevention of scaling. Mg^{2+} adsorbed on calcite surfaces from solution is one of the most promising ions for modifying calcite surface properties, such as wettability and its affinity for organic molecules.

We investigated the modification of calcite surfaces by adsorbed Mg^{2+} using surface sensitive techniques, namely X-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM) with chemical force mapping (CFM). XPS demonstrates that at elevated temperatures, Mg^{2+} uptake increases with time (Fig. 1). CFM with a hydrophobic tip shows that when Mg^{2+} is adsorbed by calcite, the surface becomes more hydrophilic, favouring interaction with water rather than organic molecules. Our results agree with density functional theory (DFT) predictions that, depending on initial surface tension, replacement of only 10% of surface Ca^{2+} with Mg^{2+} results in a contact angle change of 45 to 80 °. [1]

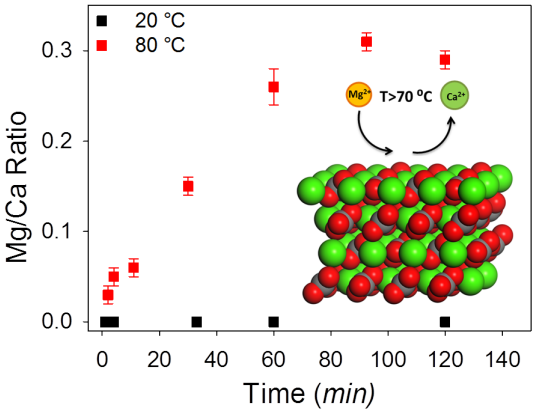

Figure 1: Mg/Ca ratio on calcite surfaces as a function of time at 20 and 80 °C, determined from XPS measurements.

[1] Sakuma, H., Andersson, M.P., Bechgaard, K. & Stipp, S.L.S. *J. Phys. Chem. C* **118**, 3078-3087, (2014).