AFM study of the adhesion of calcite surfaces in NaCl solutions

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We study the attraction and repulsion forces between two interacting calcite surfaces separated by a confined fluid film, with thickness of a few nanometers. These nano-scale forces are believed to impact how the mechanical behaviour of calcite-bearing rocks changes in response to the pore fluid chemistry. Recent studies have suggested that calcite surfaces show a strong short-range repulsion in the presence of water, which is fundamental for understanding calcite rocks water weakening phenomenon [1, 2, 3]. It has also been shown that the fracture strength of single calcite crystals is sensitive to the salinity of pore fluid [4, 5]. In this work, we study the strength of calcite in NaCl solutions by measuring the adhesion between two calcite surfaces as a function of ionic strength.

We use the Atomic Force Microscope (AFM) to measure the interaction between two calcite surfaces in a small fluid cell. A micrometer-sized fragment of calcite is glued to an AFM cantilever right before each experiment. Next we bring it to contact with an opposing freshly cleaved calcite and measure the adhesion between the fabricated tip and calcite surface [1]. We investigate the effect of ionic strength, applied force, contact area and time on the force required to separate the calcite surfaces, as a measure of the adhesion. We find that adhesion forces show a positive correlation with the ionic strength of the solution. The adhesion also increases with applied force. This is an indication of kinetic processes taking place at the contact points. However, because we see no correlation with time, this is not due to plastic deformation of asperities.

Since calcite is the main component of chalk, the result of this study can further aid interpretation of the chalk compaction.

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