



The effect of electrolytes on dolomite dissolution: nanoscale observations using *in situ* Atomic Force Microscopy

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Dissolution of carbonate minerals is one of the main chemical reactions occurring at shallow levels in the crust of the Earth and has a paramount importance for a wide range of geological and biological processes. Calcite (CaCO_3), and to a lesser extent dolomite ($\text{CaMg}(\text{CO}_3)_2$), are the major carbonate minerals in sedimentary rocks and building stone materials. The dissolution of calcite has been thoroughly investigated over a range of conditions and solution compositions. In contrast, dolomite dissolution studies have been traditionally hampered by its low reaction rates compared to calcite and its poorly constrained relationship between cation ordering and reactivity (Morse and Arvidson, 2002). Yet important questions like the so-called ‘dolomite problem’ (e.g. Higgins and Hu, 2005) remain unresolved and more experimental work is needed in order to understand the role of other dissolved species, such as soluble salts, on the kinetics and mechanism of dolomite dissolution and precipitation. We have explored the effect of different electrolytes on the dissolution rate of dolomite by using *in situ* Atomic Force Microscopy (AFM). Experiments were carried out by passing alkali halide, nitrate and sulfate salt solutions (NaCl , KCl , LiCl , NaI , NaNO_3 and Na_2SO_4) with different ionic strengths ($\text{IS} = 10^{-3}$, 10^{-2} and 10^{-1}) over dolomite $\{10\bar{1}4\}$ cleavage surfaces. We show that all electrolytes tested enhance dolomite dissolution. Moreover, the morphology and density of etch pits are controlled by the presence of different ions in solution. The etch pit spreading rate and dolomite dissolution rate depend on both (1) the nature of the electrolyte and (2) the ionic strength. This is in agreement with recent experimental studies on calcite dissolution (Ruiz-Agudo et al., 2010). This study highlights the role of electrolytes in dolomite dissolution and points to a common behavior for carbonate minerals. Our results suggest that soluble salts may play a critical role in the weathering of carbonate rocks, both in the natural environment, as well as in stone buildings and statuary, where the amount of solutes in pore waters is significant and can vary depending on evaporation and condensation phenomena.

References

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