

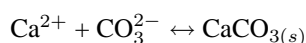


## The influence of $P_{CO_2}$ partial pressure and temperature on the kinetics of calcite crystal growth from buffered solutions.

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The influence of the specific inorganic dissolved components and physical parameters on the complex mechanism of calcite precipitation in seawater was measured in experiments where  $P_{CO_2}$  partial pressure and temperature were singularly varied. The constant addition technique was used to maintain  $[Ca^{2+}]$  at 10mmol/kg while  $[CO_3^{2-}]$  was varied to isolate the role of each variable on the precipitation rate of calcite. Similarly to seawater solutions, the calcite crystal growth reaction in NaCl-CaCl<sub>2</sub> solutions is dominated by the following reaction:



where  $k_{f1}$  and  $k_{b1}$  are, respectively, the forward and backward reaction rate constants. The net crystal growth rate, R, can be described at any given  $P_{CO_2}$  or temperature by:

$$R = k_{f1}(a_{Ca^{2+}})^{n_1}(a_{CO_3^{2-}})^{n_2} - k_{b1}$$

or

$$\text{Log}(R + k_{b1}) = \text{Log } K_{f1} + n_2 \text{Log } [CO_3^{2-}]$$

where  $a_i$  and  $n_i$  are, respectively, the activity and partial order of species involved in the reaction,  $K_{f1} = k_{f1}(a_{Ca^{2+}})^{n_1}(\gamma_{CO_3^{2-}})^{n_2}$  and  $\gamma$  is the activity coefficient.

Under our compositional conditions where  $[Ca^{2+}] \gg [CO_3^{2-}]$ , we founded that crystal growth rates were enhanced by 3 orders of magnitude as a 1000 fold increase of the  $P_{CO_2}$  partial pressure, while an increase by only one order of magnitude only was founded as a result of 10 to 30°C increase of the temperature. We propose that high  $P_{CO_2}$  partial pressures can be mainly responsible for carbon mineral sequestration in both geological and bio-induced carbonate mineral reactions.