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The influence of P_{CO2} 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 were P_{CO2} 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-$CaCl_2$ solutions is dominated by the following reaction:

$$Ca^{2+} + CO_3^{2-} \leftrightarrow CaCO_{3(s)}$$

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_{CO2} or temperature by:

$$R = k_{f1}(a_{Ca2+})^{n1}(a_{CO32-})^{n2} - k_{b1}$$

or

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

where a_i and n_i are, respectively, the activity and partial order of species involved in the reaction, $K_{f1} = k_{f1}(a_{Ca2+})^{n1}(\gamma_{CO32-})^{n2}$and γ is the activity coefficient.

Under our compositional conditions where [Ca^{2+}] $>>$ [CO$_3^{2-}$], we founded that crystal growth rates were enhanced by 3 orders of magnitude as a 1000 fold increase of the P$_{CO2}$ 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$_{CO2}$ partial pressures can be mainly responsible for carbon mineral sequestration in both geological and bio-inducted carbonate mineral reactions.