Calcite growth rate reduction by a low-molecular weight, rigid, cyclic polycarboxylic acid

P. KOUTSOUKOS[1] AND M. M. REDDY[2]

[1]Department of Chemical Engineering, University of Patras, Patras, Greece (pgk@chemeng.upatras.gr)
[2]U. S. Geological Survey, Lakewood, CO 80225 (mmreddy@usgs.gov)

Calcium carbonate (calcite) growth-rate modification impacts biogeochemical and industrial processes. Carboxylate-rich molecules influence calcification by binding to calcite mineral surfaces, slowing calcite growth rates. Here we show that calcite growth-rates, at calcite supersaturation (Ω_c)=4.5, were markedly reduced in the presence of part-per-billion (ppb) concentrations of cyclopentane tetracarboxylic acid (CPETCA)(Figure 1). Calcite growth-rate reduction with increasing CPETCA concentration followed a Langmuir adsorption model over the concentration range of 0 to 50 ppb suggesting that growth-rate reduction occurs by adsorbed CPETCA blocking calcite growth sites, on steps, or on open crystal faces. Growth morphology in the presence of CPETCA (for example, multiple irregular growth steps) was consistent with CPETCA adsorption blockage of growth sites on the calcite surface. At low CPETCA concentrations, a slow CPETCA adsorption step or CPETCA reorientation may cause the brief accelerated calcite-growth rate before the steady-state reduced calcite growth rate.

Figure 1. CPETCA Anion.