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Calcite precipitation instability under open-channel flow

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We have developed a numerical model in 2D for the carbonate system under laminar, open-channel flow across an obstruction. The model includes solution chemistry, precipitation kinetics, hydrodynamics, diffusion and gas exchange with the atmosphere. Precipitation rate is found to be elevated on the obstruction, giving a growth instability that can initiate terrace formation. The most important mechanism for this behaviour seems to be hydrodynamic advection onto and away from the carbonate surface. Enhanced degassing over the obstruction due to agitation, pressure drop and shallowing does not seem to be important, at least not locally. Diffusion control close to the calcite surface can lead to fingering growth, giving porous textures. These results are compatible with existing diffusive boundary layer theory, but still show that simple calcite precipitation models that depend on empirical relationships between flow rate and precipitation rate may be inaccurate. The model output is compared with experimental results using an oversaturated calcium carbonate solution produced from calcium chloride and sodium carbonate solutions.