

Mimicking diagenetic alteration in the laboratory: Effects on the microstructure and mineralogy of *Arctica islandica* shells

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Diagenetic alteration of ancient benthic and nekrotic marine carbonates is possibly the most significant obstacle for understanding past climate dynamics. Living organisms build local chemical environments for physiologic processes such as biomineralisation. After death these chemical disequilibria are not sustained and all tissues are subject to alteration.

We performed laboratory-based hydrothermal experiments on modern *Arctica islandica* shells. The shells were altered in solutions that simulate meteoric and burial fluids at four different temperature regimes ranging from 100 °C to 175 °C. We investigated micro- and nanostructural alteration with varying fluid composition and kinetics of the biogenic aragonite to non-biogenic calcite transition. The pristine and altered shells were characterised by X-ray powder diffraction, high-resolution scanning electron microscopy and electron backscattered diffraction.

Arctica islandica shells treated hydrothermally at 100 °C show a fine-grained microstructure and an almost randomised aragonite orientation distribution. An elevation in alteration temperatures to 175 °C leads to a coarse-grained, calcitic microstructure showing random orientation of the crystals. Aragonite to calcite transformation proceeds at shell surfaces, e.g. at its two rims, at pores and at the location of growth lines. We assume that in the case of *Arctica islandica* aragonite the alteration from highly co-oriented bioaragonite to randomly oriented inorganic aragonite is driven by internal stresses caused by organic matrices and interface energies related to the nanoscale fabric of the biogenic calcium carbonate material. Nucleation sites for the newly formed mineral are present in pores of the decomposed organic matrix.