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Cyclic growth and branching phenomena of calcite grown in Mg^{2+} containing solutions and in natural systems

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Undulosity in calcites (radiaxial fibrous calcite (RFC) and fascicular-optic fibrous calcite (FOFC)) is a common phenomenon in paleozoic and mesozoic limestones. Despite their importance as archives for climate reconstruction the underlying mechanisms and processes of their formation are still poorly understood [1]. To improve the application of such archives for climate reconstruction a better knowledge of their formation and possible alteration scenarios is necessary.

In Mg^{2+} containing gel based growth experiments calcite crystals develop pathological morphologies. The morphology can be described as a product of a geometrical selective branching process at the rhombohedral crystal faces. Multiple sheet like building blocks evolve at the branching crystal face; each slightly tilted in respect to their substrate. The product is a crystal aggregate consisting out of several misoriented sub domains. In polarized light thin section microscopy the extinction behaviour of these sub units resemble the optical undulosity of radiaxial fibrous cements.

In a multi method approach the local Mg^{2+} concentration was measured using EMPA and compared with maps of the local crystal orientation (via electron backscatter diffraction (EBSD)) and thin section microscopy. We found that Mg^{2+} is enriched at the sub-domain boundaries and deduced that lattice misfit as a consequence of impurity incorporation causes the crystal branching.

We propose that this process is cyclic and each new misoriented sheet represents a growth period after a phase of inhibited growth caused by crystal faces covered by Mg^{2+-}ions.

In comparison to natural systems we found that radiaxial-fibrous cave cements show a pathological morphology based on the same formation principles.

[1] Richter et al. (2011) Sediment. Geol. **239**, 23-36 [2] Reeder & Paquette (1989) Sediment. Geol. **65**, 239-247 [3] Davis et al. (2004) Am. Min. **89**, 714-720