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Mechanisms of bastnasite formation: replacement of calcite by rare earth carbonates.

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The interaction of rare earth bearing (La, Nd, Dy) aqueous solutions with calcite crystals at was studied at ambient and hydrothermal conditions (25-220 °C) and resulted in the solvent-mediated surface precipitation and subsequent pseudomorphic mineral replacement of calcite by rare earth carbonates. Calcite grains were replaced from their periphery inwards, and the newly formed REE-bearing carbonates follow the crystallisation sequence lanthanite [$REE_2(CO_3)_3 \cdot 8H_2O$] -> kozoite [orthorhombic $REECO_3(OH)$] -> hydroxylbastnasite [hexagonal $REECO_3(OH)$]. The specific rare earth involved in these processes and the temperature have a significant role in the polymorph selection, crystallisation pathways and kinetics of mineral replacement. La- and Nd-bearing kozoite, grows oriented onto the calcite surface, forming an epitaxy, due to their structural similarities. This phase forms elongated crystals on [100], with the {011} and {0-11} as major forms. The epitaxial relationship is (104) $[010]_{cc}$ ∥(001) $[100]_{koz}$ and is strongly dependent on the ionic radius of the rare earth in the structure of kozoite. These results have strong implications for the understanding of mineralisation reactions occurring in REE-bearing carbonatite deposits, the most important resources of rare earths in the world.