

# Nanoscale characterization of (Ca-REE) fluorcarbonates

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Micro- and nano-mineralogy of critical metals

Oral presentation

Bastnäsite and synchysite are the end-members of the homologous polysomatic series and primary ores for Rare Earth Elements (REE). Fundamental research on CaREE-fluorcarbonates holds significant potential to enhance prospecting methods, metallurgical processes, and recycling strategies. Moreover, differences in morphology, microstructure, and REE content among different CaREE-fluorcarbonates may provide clues about mineral crystallization pathways and REE partitioning in hydrothermal systems. In this context, we studied CaREE-fluorcarbonates found within the miarolitic cavities of a granophyre in the Western Southern Alps (Italy). We extended the investigation from the microscale to the atomic scale, employing scanning (SEM) and transmission electron microscopy (TEM), microanalysis and Raman spectroscopy. The observations revealed the presence of (i) synchysite-(Ce) forming hexagonal prisms and rosette-like aggregates, (ii) bastnäsite-(Ce) forming blocky aggregates and (iii) bastnäsite-(Nd) forming more complex micro and nanostructures. Moreover, at the TEM scale, bastnäsite-(Nd) exhibits a nanostructure consisting of an intergrowth of bastnäsite-(Nd) nanocrystals with hematite nanocrystals and phyllosilicates. At the end, a possible scenario about their formation has been proposed, suggesting that the different CaREE-fluorcarbonates followed a crystallization sequence as a function of temperature and fluid fractionation: first synchysite-(Ce) formed, followed by bastnäsite-(Ce) and finally bastnäsite-(Nd). The diverse morphologies, in this case, were induced not only by the dominant REE in the fluid, but also by varying temperatures and cooling rates.

Our study highlights that nature may efficiently separate REE one from the other, such as Y from La, Ce and Nd; Ce from Nd and La; and Th, a radioactive and toxic element, seems to enter the structure of CaREE-fluorcarbonates mineral during the final stages of crystallization.