$BaSO_4$ crystallization in the presence of polymers: Evidence of barite crystallization via non-classical pathways

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Barite is widely known for being a problematic and costly scale-forming mineral in industrial processes. A common strategy aimed at reducing scale formation is the addition of organic of additives. Thus a better understanding of the mechanism of barite formation from aqueous solutions and the role of organic macromolecules on such a process is relevant for the design and optimization of treatments to prevent scale formation. Here, we investigate the initial stages of $BaSO_4$ precipitation from pure and polymer-containing aqueous solutions. Barium sulphate was precipitated by combining equimolar solutions of Ba-bearing and SO_4–bearing compounds. The precipitation process was quenched at different times by the addition of ethanol or quick immersion in liquid nitrogen and subsequent freeze-drying, and the precipitates were studied by XRD, TG/DSC, FESEM, and TEM. As well, precipitation experiments (with and without polymers) were performed by the slow addition of 10 mM $BaCl_2$ solution to a 1 mM Na_2SO_4 solution. During these experiments, Ba^{2+} potential, pH, conductivity and turbidimetry were monitored. AFM growth experiments were additionally carried out. Observations of the nanostructure evolution indicate that barite forms by two-levels of oriented aggregation of nanosized particles. In pure solutions, most of the porosity in the micron-sized aggregates formed in the second steps is annealed, resulting in perfect single crystals. However, in the presence of polymers, this step is retarded and $BaSO_4$ mesocrystals are commonly observed. Furthermore, evidence supporting the existence of liquid and solid amorphous precursors that precedes the formation of the first solid (primary) particles is given.

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