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

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Barium sulphate is widely known for being a problematic and costly scale-forming mineral in industrial processes. In oil recovery, barite forms when injection water which is sulfate rich and barium-containing formation water interact downhole. Scale minerals can clog formation pores near the wellbore reducing porosity and permeability of the reservoir and they also can form a thick deposit in production pipes. A common strategy aimed at reducing scale formation is the addition of organic of additives (usually phosphonates or carboxylates) to the water injected into the reservoir (threshold treatment, *Shakkthivel et al., 2006*).

Thus a better understanding of the mechanism of barite formation from aqueous solutions and the role of organic macromolecules on such a process may be relevant for the design and optimization of treatments to prevent scale formation. Here, we investigate the initial stages of barium sulphate precipitation from pure and polymer-containing aqueous solutions. Barium sulphate was precipitated at room temperature by combining equimolar Ba^{2+}-bearing and SO_4^{2-}-bearing solutions. 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 various analytical methods, XRD, TG/DSC, FESEM, ESEM 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, the Ba^{2+} potential, pH, conductivity and turbidimetry were continuously monitored and allowed to get better insights into interactions between copolymers and prenucleation species before nucleation occurs (*Gebauer et al. 2009*).

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 step 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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References

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