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The crystallization of Na2SO4 as studied by a combination of time lapse microscopy and NMR

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Salt weathering is a major cause of deterioration of porous building materials. Of the salts responsible, especially sodium sulfate is seen as very damaging. However many questions have emerged in recent years concerning which sodium sulfate phase will crystallize out during salt.
In this study we focused on the crystallization of sodium sulfate in bulk both induced by drying and by cooling. As a major tool for studying the crystallization we have used Nuclear Magnetic Resonance (NMR). Using this technique we can measure non-destructively the moisture and ion concentration in the solution during the crystallization and get a direct indication on the phase which is crystallizing out. These NMR measurements were combined with time lapse microscopy giving the possibility to relate the concentration directly to the observed crystals. These experiments have been performed for various concentrations on both wetting and non wetting surfaces. In almost all experiments i.e. over 95%, we observed the formation of a metastable phase of sodium sulfate: the heptahydrate (Na2SO4.7H2O). These observations have been used to model the crystallization growth of heptahydrate. Only under extreme conditions we have seen the transformation into mirabilite. Hence it seems that the nucleation of heptahydrate is relevant for understanding crystallization in porous material and damage mechanism of sodium sulfate.