To make or not to make crystals from ions.

LIANE G. BENNING[1]*, SAM SHAW[2], PIETER BOTS[2],
JUAN DIEGO RODRIGUEZ-BLANCO[3], TOMASZ STAWSKI[1],
JUAN MANUEL GARCIA RUIZ[4],
ALEXANDRE E. S. VAN DRIESSCHE[4],
MERCEDES OSSORIO[4]
AND CARLOS RODRIGUEZ NAVARRO[5]

[1]Cohen Laboratory, School of Earth & Environment, University of Leeds, LS2 9JT, UK (*correspondance: l.g.benning@leeds.ac.uk)
[2]SEAES, The Univ. of Manchester, UK
[3]Nano-Science Center, University of Copenhagen, Denmark
[4]Laboratorio de Estudios Cristalograficos, Universitad de Granada, Spain
[5]Department of Mineralogy and Petrology, Universitad de Granada, Spain

The mechanisms and pathways controlling the often multi-stage reactions governing nucleation and growth of inorganic compounds from supersaturated solution are still poorly understood. This is despite the fact that such knowledge dramatically affects our ability to globaly quantify important inorganic or biologically mediated mineral formation reactions (e.g., crystallization of melts, evaporite formation, biomineralization etc.). In addition, the lack of data on mineral formation hinders our mitigation ability of antropogenically induced mineral precipitation (e.g., changes in our cultural heritage, mineral scaling in oil pipes etc.).

However, hope is on the horizont. In the last 10 years the classical view of how minerals nucleate, grow or inter-transform has dramatically changed. This is primarily due to the development and application of many novel high spatial but also *in situ* and high temporal resolution quantification methods and the advances in molecular modeling capabilites. Such tools aid our understanding of critical changes in solution parameters during nucleation (e.g., composition, specation, redox etc) but also, and importantly, many novel high resolution scattering, diffraction or spectroscopic tools specially when combined with high resolution imaging and mapping now allow us to quantify even minute changes in all physical and chemical characteteristics of particles from even prior to the initial nucleation and during each stage of growth or transformation to finally geologically stable minerals.

I will discuss the advances in the last 10 years in our understanding of nucleation, growth and transformations of $CaCO^3$ and $CaSO_4$ phases, and show how this affects our knowledge of global biogeochemical cycles or how such new information helps us take better care of our cultural heritage sites or improve industrial processes.