Scientists discover how gypsum forms—and how it might tell us more about water on Mars

April 1 2016

A new explanation of how gypsum forms may change the way we process this important building material, as well as allow us to interpret past water availability on other planets such as Mars. The work is reported in *Nature Communications*.

Gypsum (CaSO4?2H2O) is an economically important mineral, extensively used as the commercial construction material Plaster of Paris, with a global production of ~100 billion kg per year. It is a ubiquitous mineral on the Earth's surface, and is also found on the surface of Mars. Despite its importance, until now we have not understood how gypsum grows from ions in solutions.

The formation of gypsum, from concentrated aqueous solutions of calcium sulfate, was thought to be a simple, single-step process. However, a group of European geochemists has now shown that gypsum forms through a complex 4-step process: the understanding of this process opens the way to more energy efficient production of plaster.

The multinational team examined the process using in situ and time resolved synchrotron-based X-ray scattering at Diamond Light Source (Harwell, UK), and identified and quantified each of the 4 steps of the formation process, highlighting specially that the initial moments in the reaction chain are of particular importance, because they determine the final properties of gypsum.

In this 1st step, tiny sub-3 nm elongated particles form the primary building blocks (bricks). In subsequent steps these bricks aggregate, self-assemble and rearrange themselves, and finally transform to gypsum crystals.

"Importantly, we envisage that it is possible to alter this pathway by specifically targeting individual stages. For example we could arrest the reaction at the first stage when only nano-bricks are formed, and thus directly synthesise a highly reactive precursor to Plaster of Paris" said Dr. Thomas Stawsky (University of Leeds and GFZ, Potsdam) the lead author of the study. Since plaster is normally produced by the energy-intensive heating of gypsum, such an approach would drastically reduce the cost of production, and significantly decrease the carbon footprint of the industry.

Dr Stawski continued.

"This is a multi-billion dollar industry, but basic geochemistry behind the fundamental process has not been understood. Previous attempts to understand gypsum formation depended on sampling from the solutions in which the mineral was formed and drying, so it was never clear if what we were seeing was an artefact of the process. It's like looking at an ancient mummy, you see the results of the drying process, but that gives you no real understanding of the recently-dead pharaoh they started out with. Now we have a clear idea of the process".

The senior author of the study, Professor Liane G. Benning (President of the European Association of Geochemistry (see notes for more information), and (University of Leeds and GFZ, Potsdam) highlights that:

"We know that gypsum is naturally found on Mars, so applying our current finding will also help us understand and predict the hydrological conditions at the time of gypsum formation on other planets".

The European Association of Geochemistry wishes to highlight this paper as an example of cross-collaborative and multinational excellence in European Geochemistry.

More information: Tomasz M. Stawski et al. Formation of calcium sulfate through the aggregation of sub-3 nanometre primary species, *Nature Communications* (2016). DOI: 10.1038/ncomms11177

Provided by European Association of Geochemistry