

## Mineral growth under water-limited conditions

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Element and nutrient fluxes are commonly considered to depend on the wetted surface area of mineral phases. Yet, the definition of “wetted surface area” is not straightforward. For example, calcite and forsterite crystals have been documented to recrystallize or form surface precipitates upon exposure to humid air, even in the absence of visible water [1,2]. Here, we assess the amount of water required to facilitate reaction of brucite [Mg(OH)<sub>2</sub>] with CO<sub>2</sub> to form Mg-carbonate minerals. Freshly cleaved brucite crystals and pulverized brucite ore were exposed to laboratory air and pure CO<sub>2</sub> with varying relative humidity. No liquid water was provided for reaction; water was only available as an adsorbed film, or from the mineral structure. Carbonate precipitates were identified with scanning electron microscopy and infrared spectroscopy within one week when exposed to laboratory air, and within 24 h when exposed to pure CO<sub>2</sub> with relative humidity ranging from 30-100%. Mg-carbonate precipitates were observed to coat the pulverized brucite ore, with the extent of surface coverage and size of platelets appearing to increase with higher relative humidity. X-ray microtomography images revealed that precipitation was not limited to the brucite surface; in some cases precipitates extended towards the center of brucite grains that were up to 500 μm in size. Conversely, individual rosettes of CO<sub>3</sub>-bearing secondary phases were observed only at edges of cleaved brucite crystals, and at exposed steps between brucite sheets, with no clear dependence of carbonate crystal size or distribution on relative humidity. This implies that there are crystallographic controls that may govern carbonate precipitation irrespective of the availability of water. Nevertheless, our experiments demonstrate that Mg-carbonate precipitates can form given only an adsorbed water film. This implies that for certain geochemical reactions, the presence of “wetted” surface area requires only exposure to humid air.

[1] Stipp (1998) *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **140**, 441–457. [2] Olsson et al. (2012) *Geochim. Cosmochim. Acta* **77**, 86–97.