The roles of coccolith organic components in calcite crystallization

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Calcite crystallization in coccolithophores is a remarkable example of the ability of organisms to control inorganic precipitation. The coccolith crystals, which form intracellularly inside a specialized vesicle, show species-specific morphology and nano-patterning unequaled by any synthetic crystallization approach. It is well established that the initial crystals form on the periphery of an organic scale, the base plate, and that organic macromolecules within the coccolith vesicle take part in crystal growth.

We used *Pleurochrysis carterae* as a test coccolithophore species to investigate the functional role of organic macromolecules in the formation of coccolith calcite. Mature coccoliths were harvested from laboratory cultures, and by dissolving the calcite we isolated the insoluble organic fraction that consisted of the base plates and the soluble fraction that consisted mainly of polysaccharides. Attempting to induce re-mineralization *in vitro* demonstrated that the base plate does not have any detectable propensity to nucleate calcite on its surface. However, when the soluble macromolecules and calcium ions are added to the base plates, a specific reaction occurred where calcium-loaded soluble macromolecules became aggregates at the base plate periphery, exactly where the crystals were growing *in vivo*. This macromolecular recognition reaction shows that the recognition of the crystallization site is dependent on both organic fractions (Gal *et al*., 2016).

We then added carbonate ions to this synthetic system in order to induce calcium carbonate precipitation. At specific conditions of calcium and carbonate concentrations, the dense calcium phase at the rim of the base plate served as a privileged environment that supported the nucleation and growth of calcite. Remarkably, crystallization was restricted only to this nanoscale interphase, raising the possibility that a similar process occurs *in vivo*.

References

Gal, A., Wirth, R., Kopka, J., Fratzl, P., Faivre, D. & Scheffel, A. 2016. Macromolecular recognition directs calcium ions to coccolith mineralization sites. *Science*, **353**(6299): 590–593.