LS-2563 Experiment topic

Production of crystallized calcareous structures by living organisms is a worldwide phenomenon with geological and biological importance. Inspired by chemical investigations dealing with organically driven production of crystals using organic membranes as substrates (such as Langmuir films),many experimental attempts were carried out to apply this process to formation of biominerals. In parallel a "molecular shaping"of the growing crystals was hypothesized, relying on the fact thatorganic molecules (natural or synthetic molecules) are able to interact with Ca-carbonate during precipitation experiments, modifying morphology of the growing crystals.

The objective of the experiment was to test the compatibility of such models with micro-structural and chemical patterns of naturally growing crystals produced during the early developmental stages of cultivated pearls.

Early developmental stages of cultivated pearls as test models

After grafting and formation of the pearl sac, secretion of the mineralizing compounds by the epithelial cells results in continuous production of superposed mineral layers that, in contrast to usual views, are not always made of nacre. Conversely, following the "reversed shell theory"(Taylor &Strack 2008), they should be made of calcite prisms. Actually, taking advantage of a large collection gathered during a dedicated program (GDR ADEQUA), it was possible to show that mineral/microstructural diversity is much higher, providing us with multiple case-studies in which calcite and aragonite were simultaneously formed onto the nucleus surface.

LS2563 experiment focused on these dual areas, in order to check whether or not, according to the crystallization substrate model, a corresponding difference exists in the basal layers on which these calcite/aragonite crystals were grown.

Results

Excepted a few minute interruption of measurements due to beam storage failure, the session was completely successful from a technical view point, allowing a series of relevant chemical maps and spectra dedicated to sulphur and phosphorus to be completed. The studied zones were previously selected using SEM observations of polished sections of various pearl specimens from French Polynesia. Previous electron microprobe and XANES analyses have shown the role and speciation of sulphur in both shells and pearls (Cuif et al. 2008, 2011; Dauphin et al. 2013). Nevertheless, the possible variability and the role of phosphorus were not investigated at that time.

At the basement of the pearl layer, formation of calcite prisms or aragonite units (that exhibits sometimes a specific prismatic microstructure) appears independently of specific substrates.In addition, the sequence of mineralizing layers shows many examples of transitional situation in which calcite prisms progressively replace aragonite structures or *vice versa.*

This series of converging results clearly indicates that crystallization within a given layer is controlled only by the specific distribution of the organic mineralizing compounds secreted by the pearl-sac epithelium. In addition, results suggest that a crystal shaping mechanism actually exists but it relies on the insoluble components (the so-called “envelopes”) and not on the hypothesized shaping influence of small molecules adsorbed onto the face of a growing crystal.

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