Organization of calcified biomaterials: The prismatic microstructures of molluscs

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The degree to which biological control is exercised compared to physical control of the organization of biogenic materials is a central theme in biomineralization. Here I examine the so-called columnar prismatic microstructures, which consist of either calcite or aragonite prismatic crystals which grow perpendicular to the shell surface and that are surrounded by thick organic membranes. The latter impart the aggregates a high flexibility, thus making them important functional materials. Recently, the development with growth of the prismatic variety has been explained based on normal grain growth theory [1] [2]. Nevertheless, calcite domains are simple polygons in outline only when organic membranes are present, while without they are much more complex. Moreover, such domains are frequently polycrystalline. Detailed examination of the organic membranes reveals that thay display a dynamics in accordance with the von Neumann-Mullins law for 2D foam, emulsion, and grain growth [2] [3]. Taken together with the facts that the organic cavities are produced first, and that they can be found even without the mineral infilling, this indicates that it is the membranes, not the mineral prisms, that control the pattern, and the mineral enclosed within the organic membranes passively adjusts to the dynamics dictated by the latter. In prismatic aragonite, although there is evidence that the organic membranes also dominate the pattern, there is not a preformed system of organic cavities. This is probably because the growing crystalline units are spherulithic and, when they impinge with each other, they acquire much more typical polygonal outlines, being therefore much easier to deal with than calcite. In any case, for the system of organic cavities to evolve and remain continuous with shell growth, the cells of the secreting epithelium must develop a well orchestrated strategy. In particular, the different parts of a single cell must be producing either organic or carbonate material at the same time, secretion being mediated by recognition mechanisms.

[1] Bayerlein *et al*. (2014) *Nature Mater*. **13**, 1102-1107. [2] Sommerdijk & Cusack (2014) *Nature Mater*. **13**, 1078-1079. [3] Von Neumann (1952) in *Metal Interfaces*, ed. Herring, C., pp. 108-110. [4] Mullins (1956) *J. Appl. Phys*. **27**, 900-904.