2.7.P03

Calcite crystal growth under organic control

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The aim

Biominerals are organized composite materials composed of a mineral phase and specific organic substances. Well known examples of such composites are nacre and bone, wherein mineral tablets are embedded in matrices of water-insoluble organic networks. But organic substances generally are also a structural part of single-crystalline biomineral subunits. These molecules are highly functional and soluble in water. Despite their low concentration relative to the mineral component they seem to have a considerable influence on the materials mechanical properties. Some calcitic biomineral units, e.g., sea urchin spines, optically appear to be single-crystalline, but they show isotropic fracture behaviour untypical of calcite crystals. This feature may arise from a systematic intercalation of macromolecules in between aligned crystal domains, which deflect strain from the usual calcite cleavage plains. The process leading to the precipitation of such composites, though, is subject to speculation and has never been observed directly.

Approach

Crystal growth experiments were carried out on calcite substrates in the presence of polypeptides in solution. In situ observations by atomic force microscopy (AFM) provided detailed insight into precipitation processes on nanometre-scale.

Organic control of inorganic crystal growth

Specific interactions between mineral ions, acidic polypeptides and the calcite lattice lead to an oriented crystallite growth pattern. Nano-faces of crystallites are probably stabilized by adsorbed organic molecules. Though the chemical conditions required for this experimental cluster growth have to be considered as physiologically extreme, this pattern of crystal growth may be the principle by which proteins get incorporated into single-crystalline biomineral units.

2.7.P04

Calcite – aragonite in Cretaceous belemnite rostra

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Urey et al. [1] have calculated the lifetime of a belemnite from oxygen isotopic composition on the hypothesis that belemnitid rostra are formed by primary biogenic low-Mg calcite. This hypothesis is widespread, thus, when aragonitic rostra are discovered, they were excluded from the Belemnitida and new taxa are created. However, the coexistence in the same rostrum of both aragonitic and calcitic components has been reported in true Belemnites [2].

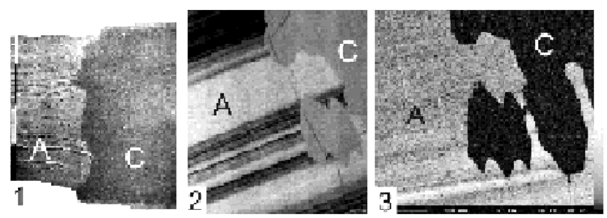

Fig. 1: secondary electron image; Fig. 2: backscattered electron image; Fig. 3: Sr map. (A=aragonite; C=calcite)

The size of the calcitic component is larger than that of the anterior aragonitic part (Fig. 1), and the calcite-aragonite boundary transects the growth lines [3]. In the aragonitic component, thin prisms are arranged in concentric growth lines, as shown by BSE image and Sr map (Figs 2, 3). The coarse calcitic prisms of the posterior part are similar to those of entirely calcitic belemnites. Growth lines are not clearly visible.

A comparison of shells with undisputed mineralogy from the same site shows that the aragonitic shells show effects of diagenetic alteration. However, these samples favor the hypothesis that belemnite rostra are composed of primary aragonite, as all other Cephalopod shells are. Calcitic and aragonitic rostra are also known in other Dibranchiata such as Triassic Aulacoerida and Eocene *Belopterina* [4].

Diagenetic changes such as shown here may clearly affect palaeo-environmental interpretations based on carbonate shells.

References

[1] Urey et al. (1951) *Geol. Soc. Am. Bull.* **62,** 399-416.
[2] Teys et al. (1978) *Geoch. Intern.* **1,** 74-81.
[3] Barskov et al. (1997) *Geodiversitas* **19**, 669-680.
[4] Dauphin, Y., (1988) *Bull. Mus. Natn. Hist. Nat. Paris* 4è sér., **10**, C2, 107-135.