

2.7.33

Morphology and texture of the fibrous calcite in terebratulide brachiopode shells

W.W. SCHMAHL¹, E. GRISSHABER¹, R. NEUSER¹,
A. LENZE¹ AND U. BRAND²

¹Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum; D-44780 Bochum, Germany (wolfgang.schmahl@rub.de; erika.griesshaber@rub.de; rolf.neuser@rub.de; anette.lenze@rub.de)

²Brock University, St. Catharines, St. Catharines, Ontario, Canada L2S 3A1 (ubrand@spartan.ac.brocku.ca)

Brachiopod shells belong to the most important fossil records of paleoceanographic isotope data and they are an intriguing object for biomaterials science. Shell structure and growth need to be investigated to understand materials the stable isotope signal of the shells, which indicates disequilibrium with seawater [1].

We investigated the ultrastructure of the primary secondary layer of the calcite shell of the terebratulide brachiopode *Megerlia truncata* with SEM and electron beam backscattering diffraction. The primary layer is nanocrystalline. The secondary layer is an inorganic/polymer fibre composite material. The fibrous calcite crystals of the secondary layer show a preferred shape orientation and a preferred crystallographic lattice orientation. The local crystallographic texture is a fibre texture with <001> as the axis, while the morphologic fibre axes are perpendicular to <001>. The morphological fibre axis is in an arbitrary direction within the (001) plane. The <001> texture axis is parallel to the radial vector of the shell vault. This arrangement minimizes the danger of shell fracture by calcite crystal cleavage.

Each individual cell of the outer epithelium producing the secondary layer secretes a single crystal fibre lined with cell wall material. The curving of these fibrous crystals is caused by lateral displacements and/or local rearrangements of the secreting cell array, and the surface of the existing crystal always serves as the substrate for crystal growth continuing the existing lattice, irrespective of crystallographic growth direction. Fibrous growth occurs parallel to as well as perpendicular to the overall growth vector of the shell, and thus the elegant "conveyor belt" model of secretory cell generation and movement put forward by Williams [2] needs to be revisited.

References

- [1] Auclair A-C., Joachimski M.M. and Lécuyer C. (2003) *Chem. Geol.* **202**, 59-7.
[2] Williams A. (1971) *Smithsonian Contrib. Paleobiol.*, **3**, 47-67.

2.7.41

Polysaccharides in coccolith biomineralization: Site-specific interaction with the calcite surface

K. HENRIKSEN¹, S.L.S. STIPP¹, J.R. YOUNG² AND
M.E. MARSH³

¹NanoGeoScience, Geological Inst., Copenhagen University, Øster Voldgade 10, 1350 Copenhagen K, Denmark (khenriksen@geol.ku.dk; stipp@geol.ku.dk).

²Natural History Museum, Cromwell Road, London SW7 5BD, U.K (j.young@nhm.ac.uk).

³University of Texas, Dental Branch, 6516 M.D. Anderson Blvd., Houston, TX 77030, USA (Mary.E.Marsh@uth.tmc.edu).

Organisms can exert intriguing levels of control mineral nucleation, crystallographic orientation and growth. Calcite is regulated in this way by unicellular algae, producing coccolith shields to cover their cell walls. Coccoliths are a few micrometers across and consist of interlocking crystals of complex shape. Coccolith biomineralization is known to involve complex organic molecules (coccolith associated polysaccharides, CAPs), believed to be important for nucleation and growth, although the mechanisms by which they function are unknown.

Using atomic force microscopy (AFM), we investigated the interaction of CAP from the species *Emiliania huxleyi* with the calcite surface during precipitation, dissolution and dynamic equilibrium. The adsorption of the organic material on the mineral surface was imaged. It demonstrated a preferential interaction of CAP with acute surface sites. Blockage of these sites during growth causes the inorganically stable {1014} face to grow preferentially in the obtuse directions, developing faces with lower angles to the c-axis. Nanoscale AFM of *E. huxleyi* demonstrated that this is precisely the type of faces that define the coccolith crystals. Therefore, we interpret that CAP functions to control crystal morphology in coccolith biomineralization, through site-specific interaction with the mineral surface.

Figure 1: AFM image of CAP adsorbed to calcite.

