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Microstructural changes reflect the degree of diagenetic alteration in biogenic carbonates

Laura A. Casella (1), Erika Griesshaber (1), Rolf Neuser (2), Kevin Stevens (2), Anne-Christine Ritter (2), Jörg Mutterlose (2), Uwe Brand (3), Adrian Immenhauser (2), and Wolfgang W. Schmahl (1)

(1) Department of Earth and Environment Sciences, LMU München, Germany , (2) Institute for Geology, Mineralogy and Geophysics, Ruhr-Universität Bochum, Germany , (3) Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada

Living systems are far from thermodynamic equilibrium as they control the immediate chemical envi¬ron¬ment, they live in by physiologic processes and the production of organic biopolymers. As biopolymers degrade after death, disequilibrium is not sustained and the micro- and nanostructure of the skeleton will be altered by diagenesis. Diagenesis is a significant obstacle in carbonate archive research and, thus, in the reconstruction of paleoclimatic and paleoenvironmental parameters. Post-depositional processes may alter the micro- and nanostructure and geochemistry of biogenic carbonates.
In our study, we use electron backscatter diffraction (EBSD), cathodoluminescence (CL) and electron microprobe (EPMA) analysis to assess the type and degree of diagenetic alteration recorded by the micro- and nanostructures and major element compositions in the low-Mg calcite of brachiopods. This unique combination of screening tools allows us to divide brachiopod samples into two groups. Group 1 material, where the entire shell is either highly or negligibly overprinted, and material of group 2 where the shell contains some pristine but also heavily overprinted areas. We base our assessments on changes observed in calcite crystal orientation patterns that correlate well with optical overprint signals and elemental enrichments and depletions in shell carbonate. In the case of samples where we observe in the same shell both, pristine and overprinted shell portions, alteration occurs either along the periphery of the shell including the primary layer and the surface of the fibrous/columnar layer facing the interior sediment. We observe a further mode of overprint. In this instance, diagenetic fluids moved through punctae causing overprinting in their immediate vicinity, while between the punctae pristine shell portions are preserved. The combination of screening methods that we use in our study clearly allows an identification of diagenetic alterationas as well as the assessment of the degree of alteration. However, as these methods are highly time consuming large sets of samples cannot be processed within realistic time intervals.