# EVOLUTION OF THE STRUCTURE OF CALCIUM CARBONATE PRECIPITATES FORMED IN THE PROCESS OF BIOMINERALIZATION

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Biomineralization, a phenomenon of the mineral formation by living organisms, is widespread in nature. During the metabolic reactions the various bacteria often induce calcium carbonate precipitation in soil and rocks or form an encrusted biofilms that clog urinary catheters, causing significant problem in clinical practice [1]. The ongoing research of the biomineralization mechanisms is important for solving the clinical problems by inhibition of calcite crystallization, as well as for application of new technologies to restore concrete structures securing integrity of porous media, hydraulic control and restoration of the environment [2, 3, 4]. Abiogenic calcium carbonate crystallization is known to pass through several stages, during which the amorphous phase is successively transforming into vaterite and then calcite/argonite, as shown by the FTIR method in in situ experiments [5]. However, this process can be significantly altered by bacterial cells and their extracellular matrix (ECM). In our work, SANS, FTIR, XRD, SEM and confocal microscopy methods were used to study the evolution of the precipitated calcium carbonate structure formed during biomineralization by the bacterium Bacillus licheniformis DSMZ 878 in a planktonic culture. The precipitates containing amorphous CaCO3 in the form of fractal aggregates were detected at 24 hours of bacteria's growth in the Ca2+ and urea-rich medium. Fractal clusters hundreds of Angstroms in size and the fractal dimension near 2.7 (volume fractal) were detected in the precipitate. Observed over 14 days transformation of CaCO3 polymorphs along the ACC-vaterite-calcite/aragonite pathway was accompanied by a significant increase in the characteristic size of the fractal clusters and compaction of their structure yielded in an increase in the dimension of the volume fractal. The co-localization of CaCO3 precipitates with components of ECM that included charged macromolecules (extracellular DNA, amyloid proteins and polysaccharides), was confirmed by confocal fluorescent microscopy using specific fluorescent dyes, indicating that ECM could serve as a template for the mineral formation.

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