

A Structural View of Carbonate Biomineralization by Bacteria

François Guyot, Karim Benzerara, Nicolas Menguy, *Institut de Minéralogie et de PMC et Institut de Physique du Globe de Paris, France*. E-mail: guyot@lmcp.jussieu.fr

Although it has been recognized for more than a century, biomineralization of carbonate minerals by prokaryotic organisms has been much less studied, from a structural point of view, than the formation of calcite and aragonite by eukaryotic cells. Formation of carbonates by bacteria and archaea has however a potential strong environmental significance, for example for immobilization of radionuclides under aridic conditions or for deep geological carbon dioxide mineral sequestration.

Investigation tools such as analytical transmission electron microscopy and synchrotron-based scanning transmission x-ray microscopy have allowed us to evidence, at nanometer scale, the well known, yet poorly understood, systematic relationship between bacterial extra-cellular polysaccharides and carbonates. We report examples from mineral (pyroxene) surface micro-habitats and from lacustrine carbonate microbialites. Nanobacterial-like morphologies are characteristic of these carbonate crystals, the formation mechanism of which will be discussed.

A second mode of carbonate and phosphate biomineralization by bacteria has also been evidenced. It is radically different in that it involves intracellular, particularly periplasmic, components. Possible mechanisms implying periplasmic protein activity (e.g. alkaline phosphatase) and metabolic activity (e.g. sulfate reducing bacteria) will be reviewed.

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