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Microbial Carbonates: Bacterial Metabolism, Exopolymeric Secretions *and Communication*?

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Net precipitation of calcium carbonate results from complex biotic, geochemical and physical interactions (Dupraz and Visscher, 2005). In microbialites, or lithifying microbial mats (organosedimentary systems, Des Marais 2000), precipitation and dissolution of calcium carbonate is supported by at least three key processes, which are interconnected: 1) microbial metabolism, which alters the microenvironment surrounding the cell (impacting the saturation index); 2) production and alteration of microbial exopolymeric secretions (EPS), by which the calcium activity changes (and a precipitation template; may be formed); 3) quorum sensing (or microbial communication), through which certain types of metabolism are turned on or off.

Through metabolic reactions, microorganisms alter the chemical composition of their environment. Different metabolic pathways do this in different ways (Visscher & Stolz 2005), and even small modifications of a specific metabolic pathway can result in different environmental geochemical changes (e.g., Wright & Oren 2005, Baumgartner et al. 2006). The bottom line is that the saturation index, which is a function of the activity of carbonate and calcium ions, is modified by microbial activities, the net result of which could be precipitation or dissolution of carbonates (Dupraz & Visscher 2005).

The exopolymeric matrix (EPS), secreted and modified through biotic and abiotic reactions, plays a dual role in carbonate precipitation: initial inhibition by fresh EPS results from calcium binding, while calcium (and carbonate) release follows during partial degradation of these secretions. In microbial mats, cyanobacteria play a key role in this process, but we will present data that demonstrate the involvement of other bacteria in EPS production. The degradation of EPS by consortia was postulated (Decho et al. 2005), and we will show here which microorganisms may play a key role in this process.

Finally, microbial communication through so-called quorum sensing (QS) is known to regulate metabolic processes (Fuqua & Greenberg 2002), including on/off switching of metabolism and EPS production. QS is mediated by acylated homoserine lactone (AHL) molecules, a variety of which has been found in microbial mats. The physico-chemical conditions influence the stability of these AHLs, forming another layer of complexity to be considered in carbonate precipitation, raising the question whether bacteria “discuss” the onset of lithification in their environment.

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