Carbonate Biomineralization Induced by *Bacillus megaterium*

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We investigated carbonate biomineralization mediated by an eubacteria, *Bacillus megaterium*, isolated from a loess profile in China. Upon completing bacterial cultivation, the ensuring products were centrifuged and the crystallization experiments were carried out separately in the supernatant, the concentrated bacterial sludge, as well as the un-separated culture. XRD and SEM analyses indicate that calcite (Figs. A&B) was the dominant mineral phase formed when the bacterium was present. When the supernatant alone was used, however, a significant portion of vaterite (Fig. C) also precipitated. The results further reveal that the bacterium had a strong tendency to colonize the center area of the $\{10\bar{1}4\}$ calcite faces. The crystal morphology suggests that the bacterial colony (Fig. D) might have promoted the growth normal to individual $\{10\bar{1}4\}$ faces of calcite when the cell concentration was high (Fig. A), but retarded it or even caused dissolution of the immediate substrate surfaces when the concentration was low (Fig. B). In addition, SEM observed the nucleation of calcite on bacterial cell walls but do not see obvious morphological changes on the nanometer- to submicron-sized nuclei. $\delta^{13}C$ measurements prove that the crystals were further enriched in the heavier carbon isotope, implying that the bacterial metabolism was not involved in the crystallization process. Based upon these findings, we propose a mechanism for the *Bacillus megaterium* mediated calcite mineralization and conclude that the whole process involves epi- and inter-cellular growth in the local microenvironments whose conditions may be controlled by cell sequestration and proton pumping during bacterial respiration.