Bacterial mineralization of struvite and its morphogenesis

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Struvite ($NH_4MgPO_4 \cdot 6H_2O$) is an orthorhombic mineral with space group $Pmn2_1$. Although struvite is not widely found in nature, it has still been found in some peculiar environments associated with organic matter decomposition, such as guano deposits, basaltic caves, marshlands, manures, and sediments rich in organic remains, and a consensus is that bacterially-mediated mineralization is reponsible for the struvite formation. However, the bacterially mediated struvite usually crystallizes as unusual morphologies and textures. Here, to better understand the relationship between growth habit of struvite and bacterial activity in the presence of mineral substrate MgO, *Shewanella oneidensis* MR-1 was selected as a model microbe to induce struvite mineralization. The experimental results show that the growth and metabolism of *S. oneidensis* MR-1 are not influenced by the dosed MgO, and the strain is able to promote MgO dissolution, and transform organic nitrogen and organophosphorus into well-crystallized struvite. In particular, a series of FESEM analyses reveal that the struvite morphogenesis stongly depends on the dose of MgO added. At the lower dose, the struvite mainly exhibits a coffin-like habit consisting of the {001} pedion, {110} rhombic prism, {101} and {012} domes. However, with increasing MgO dose, the mineralized struvite has a contact twin structure with a special tetragonal pyramid-like habit, and an extra simple form {010} pinacoid appears in this case. On further increasing the mineral dosage, all of the struvite tends to crystallize into twined crystals consisting of two trapezoidal individuals, and the trapezoidal individual also consists of the simple forms {001}, {101}, {012}, and {010}, but preferentially grows along the *b*-axis direction relative to the coffin-like crystal. The development of special morphology and texture of the struvite crystals is mainly controlled by solution supersaturation. The results can provide a new insight into struvite biomineralization.

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