Influence of conditions past and present on bacterial mineral precipitation

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Bacterial mineral precipitation is thought to be a complex process, being influenced by biological, chemical and geological factors throughout time [1, 2]. This study focused on calcium mineral precipitation in the Cretaceous (~120Ma ago) and the present day, using marine bacteria. We investigated parameters such as (i) the Magnesium: Calcium ratio of seawater [3] and (ii) the atmospheric partial pressure of carbon dioxide [4], both of which showed great variations over time. We further investigated (iii) possible inhibitors of precipitation, (iv) availability of nutrients and (v) the necessity of metabolic active cells.

Electron-microscopy (EM) techniques, powder X-Ray diffraction and elemental spectra were used to screen the cultures for precipitates and to analyse polymorph mineralogy. For some bacterial strains, calcium mineral spheres were observed in the Cretaceous-like medium only, with a nutrient concentration of > 0.25% yeast promoting their formation. EM analysis not only revealed micropores and bacterial matter on the surface of the spheres but also demonstrated such pores in the interior of the spheres, containing cells being entombed in precipitate. For the first time these data elucidate the interplay of different parameters and their influence on the formation of bacterially induced calcium minerals in the Cretaceous.

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Microbial communities as palaeoenvironmental indicators during black shale-hosted manganese ore formation

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The Jurassic (Lias) black shale-hosted Mn-carbonate ore deposit was studied by XRD mineralogy (260) and rock microscopy (80) to determine mineral components and microstructure to better understand the sequence of microbial communities that existed during ore accumulation. Formation of the main Mn ore bed in the Úrkút deposit occurred via a two-cycle bacterial sequence: (1) an aerobic, chemolithoautotrophic microbial cycle, followed by (2) an anaerobic bacterial cycle. During cycle 1, microbial Mn (II) enzymatic oxidation resulted in the fine-grained accumulation of biooxides (with reactive organic matter), which later transformed during diagenesis into Ca-rhodochrosite via bacterially mediated processes during early suboxic diagenesis [1, 2]. These redox conditions supported celadonite formation from the mixing of warm geofluids with seawater. This clay formation occurred at the sediment/seawater interface or near it during synsedimentation or very early diagenesis under neutrophylic pH. The near seabed environment was continuously dysoxic-suboxic and was colonized by Fe (II) oxidizing microbes. Those microbs were interlaced with the host sediment and probably initially concentrated ferrihydrite, which was later transformed to goethite. Conditions became more reducing with a higher rock/water ratio during burial. This resulted in smectite formation and pyritization of goethite in the zone of bacterially mediated sulphate reduction.

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[1] Polgári *et al.* (1991) *JSP* **61**, **3**, 384–393. [2] Polgári *et al.* (2011) *OGR* submitted.