Sensitivity of Carbonate Precipitates to Iron Reducing Physiology

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Microbial iron reduction is associated with a wide range of Fe/Ca ratios in natural carbonate cements [1]. The details about how iron reducing bacteria affect the composition and morphology of carbonate are not clear. Varying solution compositions and iron reducing physiologies were investigated to understand how the specific mechanisms of a ubiquitous metabolism can impact carbonate precipitation.

Solution chemistry exerted a critical control on carbonate precipitation by modifying grain morphology and changing mineral composition.

However, different physiologies of iron reduction were observed to produce different carbonate precipitates (Table 1), even under the same bulk solution compositions. Iron reducing bacteria apply diverse physiologies to transport electrons to solid iron minerals, including membrane-bound enzymes, soluble electron shuttles, and proteinaceous nanowires [2]. Differences in precipitates were likely controlled by compositional and physical differences in the local environments of iron reduction.

Physiology	Mineral composition	Mineral morphology
Membrane-bound enzymes	siderite, Ca-siderite, Fe-calcite	rhombohedra, conjoined spheres, spheres, sheafs
Soluble shuttles	siderite, Ca-siderite	rhombohedra, spheres, chains
Nanowires	Ca-siderite	rhombohedra

Table 1: Precipitates formed by different physiologies.

These results suggest that iron reducing bacteria introduce considerable complexity to carbonate precipitation that is difficult to predict from simple thermodynamic models. This complexity arises in part from sensitive dependence on iron reducing physiologies, raising the possibility that characteristics of the resulting precipitates may encode information about the bacteria involved.

[1] Gluyas (1984) *Clay miner* **19**, 309-321 [2] Weber *et al* (2006) *Nature Reviews Microbiology* **4**, 753-764