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Biomineral formation as a biosignature for microbial activities Precambrian cherts

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In recent anoxic sediments manganese(II)carbonate minerals (e.g., rhodochrosite, kutnohorite) derive mainly from the reduction of manganese(IV) compounds by microbial anaerobic respiration. Small particles of rhodochrosite in stromatolite-like features in the Dresser chert Fm (Pilbara supergroup, W-Australia), associated with small flakes of kerogen, account for biogenic formation of the mineral in this early Archaean setting. Contrastingly, the formation of huge manganese-rich (carbonate) deposits requires effective manganese redox cycling, also conducted by various microbial processes, mainly requiring conditions of the early and late Proterozoic (Kirschvink et al., 2000; Nealson and Saffrani 1994). However, putative anaerobic pathways like microbial nitrate-dependent manganese oxidation (Hulth et al., 1999), anoxygenic photosynthesis (Johnson et al., 2013) and oxidation in UV light may facilitate manganese cycling even in a reducing atmosphere. Thus manganese redox cycling might have been possible even before the onset of oxygenic photosynthesis. Hence, there are several ways how manganese carbonates could have been formed biogenically and deposited in Precambrian sediments. Thus, the minerals may be suitable biosignatures for microbial redox processes in many respects. The hyperthermophilic archaeon *Pyrobaculum islandicum* produces rhodochrosite during growth on hydrogen and organic compounds and may be a putative model organism for the reduction of Mn(IV).

References

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