Carbonate matrix formation resulting from nitrogen remineralization and enzyme activity

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The microbial nitrogen cycle has been identified as a principal pathway involved in the formation of marine calcium carbonate deposits. However, to date clear evidence about carbonate genesis facilitated nitrogen remineralization is dissatisfactory. In addition, also the potential of microbial carbonic anhydrase, a carbonate-relevant, zinc-containing enzyme, for carbonate formation is receiving currently increased attention. Here we demonstrate microbial-mediated carbonate precipitation as a direct result of the interplay between the microbial nitrogen cycle and a microbially produced enzyme. Using *Alcanivorax borkumensis* as a model organism, our experiments depict precipitation of a micritic carbonate matrix. Simultaneous extracellular carbonic anhydrase activity and ammonification induced a carbonate matrix with primary porosity and dendritic structures, within weeks. The precipitates show similar morphology, mineralogy, $\delta^{44/40}$Ca, and $\delta^{88/86}$Sr to analogues of natural marine coastal carbonate deposits. The observed relative enrichment of the precipitates in zinc might help to constrain zinc variations in natural carbonate archives. Our study demonstrates that ammonification and carbonic anhydrase may play a substantial role for carbonate microfacies genesis in marine environments characterized by intense microbial organic matter degradation.