Carbonic anhydrase- a geological relevant enzyme?

S. KRAUSE[1], V. LIEBETRAU[1], A. EISENHAUER[1] AND T. TREUDE[1]

[1]GEOMAR Helmholtz Centre for Ocean Research, Department of Marine Biogeochemistry, Wischhofstrasse 1-3, 24148 Kiel, Germany, skrause@geomar.de, vliebetrau@geomar.de, aeisenhauer@geomar.de, ttreude@geomar.de

Todate, in the context of calcium carbonate precipitation, the role of marine microbes is widely reduced to i) the delivery of alkaninity due to anaerobic respiration and ii) the concentration of cations by organic molecules. Both inducing local supersaturation, governing subsequent mineral formation. However, recent studies indicate that also the activity of microbial carbonic anhydrase provokes the precipitation of copious amounts of calcium carbonate. In particular, the strong carbonate precipitation potential of aerobic marine microbes in the presence of carbonic anhydrase appears contradictory, as CO_2 production constricts carbonate formation. The present study provides laboratory experiment results of carbonic anhydrase-driven calcium carbonate precipitation by the marine sedimentary bacterium strain *Alcanivorax borkumensis* SK2 under modern seawater conditions. The analyses of the calcium carbonates included the functional relationship between the presence/concentration of carbonic anhydrase and the onset of precipitation. In addition, isotope-geochemical, mineralogical, and high-resolution microscopy methods were utilized to constrain the chemical pre-conditions of the bulk liquid and to characterize the carbonates. The results showed that carbonic anhydrase, produced by the bacteria strain induced intense precipitation of high Mg-calcite (14% $MgCO_3$), representing a common precursor carbonate mineral in the rock record, prone to diagenetic alteration. In the initial phase, nucleated crystals appeared in a "dumbbell"-shape, progressively evolving to spherical crystals of > 20 μm in diameter. The observed shapes resemble micritic carbonate, frequently present in the rock record. Based on the study results, a conceptual model for carbonic anhydrase-driven calcium carbonate precipitation is developed and the potential geological relevance of this alternative pathway is discussed.