Geophysical Research Abstracts
Vol. 12, EGU2010-9657-1, 2010
EGU General Assembly 2010

Scleractinian corals cultured in low Mg/Ca seawater form aragonite skeleton

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Scleractinian corals represent a testing ground for ideas regarding biologically vs. environmentally controlled calcification. The morphology of skeletal micro-structural units (arrangement of the skeletal fibers) and their biogeochemical composition have, for a long time, been interpreted from two opposite view points: (1) as a purely physico-chemical process involving simple supersaturation of a fluid close in composition to seawater, hypothesized to exist at the interface between the skeleton and the calicoblastic cell-layer, or (2) a complete physiological control of calcification by the organism by means of a presumed amorphous precursor phase and precisely utilized organic macromolecules that control mineralogy, crystal orientation etc.

Paleontological data originally supported the second interpretation because the aragonitic skeletal mineralogy appeared to be stable through geological time despite of changes in seawater chemistry (e.g., the late Mesozoic decrease of Mg/Ca ratio), which was believed to promote inorganic precipitation of calcite. However, Ries et al. (Geology 2006, 34: 525-528) argued that scleractinians are so-called 'hyper-calcifiers' and limited in their mineralogical control. Accordingly, in modern seawater (Mg/Ca molar ratio = 5.2) such organisms form aragonite simply because the Mg/Ca ratio favors this mineralogy. However, if the Mg/Ca ratio drops below 3.5, the mineralogy of such 'hyper-calcifiers' are supposed to become calcitic. In low-Mg/Ca experiments, Ries et al. detected calcite by X-ray diffraction of the bulk skeleton of *Acropora*, *Montipora*, and *Porites* and also indicated, by electron microprobe analyses, the presence of calcite in the uppermost portion of coral skeleton, though the exact position of the mapped areas were not indicated.

We have cultured *Acropora*, *Porites*, *Pavona* and *Galaxea* in low Mg/Ca (compared with normal seawater) artificial seawater (ASW). A low Mg/Ca ratio can be obtained either by lowering the Mg concentration or by increasing the Ca concentration. In our experiments, we did both. Before the corals were exposed to low Mg/Ca ASW conditions, they were labeled with ^{86}Sr for 3 days, following procedures described in Houlbreque et al. (GRL 2009: doi:10.1029/2008GL036782), in order to precisely define the skeletal growth front at the start of the experiment. ^{86}Sr labeled corals were transferred to aquaria with ASW with Mg/Ca = 2. In the experiment in which a low Mg/Ca ratio was obtained by lowering the Mg concentration, the corals immediately died, presumably because Mg is an element required in metabolism. In the experiment in which the low Mg/Ca ratio was obtained by increasing the Ca concentration, the corals appeared unstressed (tentacles extended) and they were kept alive for 30 days. Subsequent NanoSIMS imaging showed that the ^{86}Sr-labelled growth front in *Porites*, *Pavona*, and *Galaxea* had been overgrown by a ca. 10-20 μm newly formed skeleton. The ^{86}Sr label was not incorporated into *Acropora* specimens, most likely because skeleton formation had ceased during handling, perhaps because of stress or sickness in this species. Micro-raman mapping demonstrated an exclusively aragonitic mineralogy of the skeleton formed in the low Mg/Ca ASW. This indicates that scleractinian corals form their skeleton under a biologically control that renders the skeletal mineralogy insensitive to even large variations in the Mg/Ca ratio of the ambient seawater. Additional experimental observations, not mentioned here due to length limitations, will be presented at the meeting.