Riding, R. 2005. Secular variations in abundance of calcified algae and cyanobacteria: how biomineralization can reflect global changes in temperature and water chemistry. System Earth-Biosphere Coupling, Erlangen, September 24-29, 2005. Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften Heft 39: 312.

Secular variations in abundance of calcified algae and bacteria: how biomineralization can reflect global changes in temperature and water chemistry

Robert Riding
School of Earth, Ocean and Planetary Sciences, Cardiff University, Cardiff CF14 0XH, Wales, UK
(riding@cardiff.ac.uk)

In calcareous algae and cyanobacteria, cellular site and mineralogy of calcification, together with biogeographic range, relate to the degree of control exerted by the organism over calcification. With decreasing control, site of calcification moves from intra- to extra-cellular, mineralogy shifts towards that of ambient abiotic carbonate precipitates, and environmental distribution becomes restricted to environments in which inorganic precipitation is favoured (warmer water in marine environments). Strong control (e.g., corallines) allows wide environmental distribution of biocalcification, is linked to intracellular site of $CaCO_3$ nucleation, and results in a polymorph not necessarily in equilibrium with the ambient environment. In contrast, weak control (e.g., cyanobacteria and green algae such as dasycladaleans and halimedaceans) limits the environmental distribution of biocalcification, is linked to extracellular site of $CaCO_3$ nucleation, and results in a polymorph in equilibrium with the ambient environment.

Coccolithophores, corallines, chlorophytes, and cyanobacteria exhibit decreasing degrees of control over calcification. The mineralogy and composition of calcification products towards the end of this series more and more approximate those of ambient abiotic carbonates. Simultaneously, the site of calcification becomes more external to the cell, and the environment of distribution becomes more restricted.

Through time, cyanobacteria and green algae that weakly control calcification respond sensitively to changes in sea-water chemistry affecting $CaCO_3$ precipitation. Periods when these groups were abundant and diverse, and show wide latitudinal ranges, correspond with times of elevated seawater saturation state, and also with high global temperature, which further increases saturation state for $CaCO_3$ minerals. They therefore behave as indicators of environmentally controlled precipitation. Groups such as corallines and coccolithophores that closely control calcification are less subject to these factors.

In common with all marine organisms, the geological history of calcified algae and

bacteria will reflect evolutionary responses to changing ecological and environmental conditions. Here I suggest that it also reflect differences in biomineralization. Cyanobacteria and green algae such as dasycladaleans and halimedaceans control their calcification less than coralline red algae and coccolithophores. Consequently, calcified cyanobacteria and green algae have been more widespread and diverse at times when global temperatures and seawater saturation state have been higher. Calcified algae and bacteria therefore have great potential to reflect past fluctuations in environmental controls over carbonate precipitation.