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Biogeosciences Discussions

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Interactive Comment

Interactive comment on "The environment recording unit in coral skeletons: structural and chemical evidences of a biochemically driven stepping-growth process in coral fibres" *by* J. P. Cuif and Y. Dauphin

Anonymous Referee #3

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This paper is a nice review of coral biomineralization patterns generally and the authors' work on AFM and sulfur in coral skeletons more specifically. I enjoyed reading it and it certainly makes a good contribution to this journal. The pictures are of especially high quality with very good documentation of the various space scales involved. Starting from the macro scale and working down to the actual SEM, probe or AFM data is very helpful and informative. The one area where this could be improved is in the AFM figures. The main goal seems to be to convince the reader that corals are carbonate minerals whose main features are a direct result of various biological imprints. I did not need convincing of this point, but the arguments are generally well made and well organized. The English grammar needs to be improved but I feel this is a more minor point.

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Interactive Discussion

Discussion Paper

My only general criticism is the treatment of how this important research is linked to corals as recorders of paleoclimate. I think many of us would like to find the series of biochemical reactions and transport pathways that lead to the paleoceanographer's black box called "vital effects". This paper, and the authors' work in general, represent important steps in this direction, but I do not think the problem has been solved by any means. On page 639 the authors say, "clearly application of simple thermodynamical laws cannot provide us with accurate interpretation of environmental signals recorded in biominerals". I don't think this is true. First, there are many papers now that show at least some part of the coral skeleton is precipitated at or very near equilibrium for both stable isotopes and Sr/Ca. Clearly the corals "feel" the thermodynamic constraints as one "end-member" in their biomineralization process. Second, the regular annual cycle seen in many geochemical proxies in massive reef forming corals is clear evidence that these animals are recording key features of their environment. Establishing why this is the case, but with values offset from inorganic aragonite, is one of the important reasons for the sort of research outlined in this paper. I think that thermodynamic constraints are still very important. Low Mg/Ca ratios in coral fibers are not "meaningless" (p. 640). They are an important part of the whole story about how a coral skeleton is assembled. I still believe that coral Sr/Ca is well correlated with mean annual temperature when large samples are used. Which sets of causes lead to this correlation is of course still an open and interesting area of research.

A much smaller point is that stable isotope data generated from reacting carbonate with phosphoric acid is not very likely to be altered by small amounts of organic matter in the coral lattice. At 70°C for $\sim$10 minutes, phosphoric acid does not easily hydrolyze organic material to CO_2, especially compared to the large amount of CO_2 coming from the carbonate. I think the comments on page 635 about the recalcitrance of coral organic matter at high temperatures are very interesting, but they probably have little effect on d^{13}C or d^{18}O. The proposed model for biomineralization is fine as far as it goes. I would say that the authors have emphasized an important point; optically oriented crystals have linear features that run perpendicular to the c-axis. However, stalagmites also have this sort of mineralization pattern. In and of itself, this type of layer construction is not diagnostic of biological control. I don't think the "Mg-stop" mechanism has really been proven. The new NanoSIMS data are very interesting but the definitive model of coral biomineralization still lies in front of us.

Interactive comment on Biogeosciences Discussions, 1, 625, 2004.

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