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Coral biomineralization: A sharper optic reveals ultra-structural properties

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Coral reefs are the most prolific biomineralizing ecosystems in nature. Corals calcify faster than most other animals and outpace inorganic calcification rates on the reef by a factor of more than 100. A special feature of hermatypic corals is that they host unicellular dinoflagellate symbionts, commonly called zooxanthellae, in their tissues. Zooxanthellae are believed to influence calcification by a process referred to as "light-enhanced" (or alternatively as "dark-repressed") calcification. Thus, hermatypic corals constitute a good case for studying biomineralization, symbiosis and the interactions between both processes. Our knowledge of coral biomineralization has increased dramatically in recent years due to combined efforts of biologists, geochemists, geologists and paleoclimatologists, but the intimate mechanisms of coral skeletogenesis are still poorly understood. Micro-scale studies of coral skeletons have led to the discovery that the effects of biology on the skeletal chemical and isotopic composition are not uniform over the skeleton. Early mineralization zones, which are often referred to as centers of calcification (COC), exhibit very different stable isotopic (e.g., C, O and B) and trace element (e.g., B, Mg, Sr, Ba, N, S) compositions compared with other parts of the skeleton. Large chemical and isotopic variations have been documented in the fibrous aragonite part of the skeleton. Micro-analytical and biological observations suggest a close relationship between the structure and the organization of the tissues, and the different ultra-structural components of the skeleton. Recent work will be re-

viewed with an emphasis on data obtained by ion microprobes, especially the newly developed NanoSIMS ion microprobe, which offers unparalleled spatial resolution, down to 50 nanometers, in combination with extremely high sensitivity.