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Nano to macroscale biomineral architecture of red coral (*Corallium rubrum*)

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Abstract

Different techniques have been used to characterize the physical and chemical structure of the red coral calcitic skeleton. A section normal to the axis of the skeleton shows a medullar zone surrounded by a circular domain composed of concentric rings. Growth rings are revealed by the cyclic variation of organic matter (OM) and Mg/Ca ratio. These growth rings are annual; thus, both OM and Mg/Ca ratio can be used to date red coral colonies. Growth rings display wavelets. The internal structure of each wavelet results from the stacking of layers with tortuous interfaces. Tortuosity is due to the presence of microprotuberances. Interfaces between layers may display sharp discontinuities indicative of interruption of the mineralizing process. SEM and TEM studies show that each layer is made of (1) fibers, organized or not in fan-shaped structures; and (2) submicrometer (apparently mono-) crystalline units. Fibers are superstructures made of submicrometer units possibly assembled by an oriented aggregation mechanism. HRTEM studies show that in spite of displaying single-crystal scattering behavior, the submicrometer crystalline units are made of 2–5 nm nanograins again possibly aggregated by a mechanism of oriented attachment. Thus, submicrometer crystalline units and polycrystalline fibers can be both defined as mesocrystals. The red coral skeleton is a hierarchically organized organic-inorganic composite that exhibits porosity and structural and compositional order on length scales from the nanoscale to the macroscale.

Keywords: Red coral, growth ring, biomineralization, three-dimensional micro-nano hierarchical structure, mesocrystal, nanograin, calcite