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An integrated structural and biogeochemical model of skeletal growth of deep-sea scleractinian coral Desmophyllum

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The last several years have seen unprecedented progress in analytical techniques (e.g., NanoSIMS, X-ray microscopy, AFM, HRTEM) which allow nano- and atomic scale characterization of biominerals. These techniques exhibit improvements in spatial resolution, detection limit along with precision and accuracy in the determination of trace element concentrations, isotopic ratios and distribution of organic components. Here we present an example of integrated analyses and observations of skeletons of the deep-sea scleractinian coral Desmophyllum. This coral is a geographically and bathymetrically broadly distributed azooxanthellate genus, whose large skeleton, with a relatively simply morphology, is an excellent choice for (palaeo)climatic reconstructions.

Two main structural regions can be distinguished within main skeletal structures (wall, septa) of Desmophyllum corallum: (1) Centers of Rapid Accretion (CRA) whose successive layers of fibers are highly enriched in organic components characterized by their high S content (assumed to be mostly sulfated polysaccharides, SPS) and (2) Thickening Deposits (TD) with layers of fibers divided every several hundreds of nanometers with thin SPS-enriched regions. The spatially heterogeneous S distribution delimitates successive layers of fibers in both regions. Layers of fibers continue between CRA and TD. Fibers in CRA are composed of distinct aggregates of nanograins, whereas TD fibers show polycrystalline nature with nanograins occurring only in places. Trace elements (Mg, Sr) and carbon stable isotopes show highly heterogenous distribution of these species in vertical and horizontal directions of the skeleton. Our data suggest that cells in the calicoblastic ectoderm operate in two main modes corresponding to vertical alternations of organic-enriched and organic-depleted layers. The coral tissue seems to exhibit a spatially controlled sulfate transport activity: (1) A zone of high activity covering growing tips of the skeleton, with a central region responsible for formation of the central, organic-enriched deposits and two adjacent regions responsible for formation of TD-like fibers. (2) A zone of low activity, responsible for formation of typical TD and thickening of the skeleton.

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