Evaluation of geochemistry in hypercalcified demosponges as a paleoceanographic proxy

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Hypercalcified sponges (hereafter, “sclerosponges”), living in dark environments of tropical to subtropical shallow oceans, precipitate calcium carbonate skeleton with growth bands. They grow slowly at an approximate rate of <1 mm/year unlike corals (ca. 1 cm/year) but can be so long-lived for several decades to hundred years like corals (e.g., Benavides and Druffel, 1986 Coral Reefs). Skeletal oxygen isotopic ratios in sclerosponges can reflect variations in sea surface temperature and seawater with the latter being potentially related to salinity reflecting the precipitation–evaporation balance at the sea surface and changes in water mass transport (e.g., Grottoli et al., 2010 J. Geophys. Res.). In contrast to zooxanthellate corals, which occasionally show positive correlations between skeletal oxygen and carbon isotopic ratios, it is considered that there do not exist vital effects in the secretion of sclerosponge skeleton. Previous studies showed significant decrease trends in the carbon isotope records toward the present, which is probably a result of isotopically-light carbon dioxide added into the atmosphere/ocean from fossil fuel burning (e.g., Swart et al., 2010 Geophys. Res. Lett.). Therefore, sclerosponges are shown to provide annually resolved time series of proxy records of ocean environments since the Industrial Revolution. However, few evaluation studies on the environmental proxy of sclerosponges are reported, and temporally longer (>100 year-continuous-long) records from sclerosponges were derived only from the Atlantic Ocean.

Here we present stable oxygen and carbon isotope ratios and trace elements (Mg, Ca, Sr, Ba, Pb and U) from sclerosponges (*Astrosclera willeyana* and *Acanthochaetetes wellsi*) collected from Kume-jima, Okinawa-jima and Miyako-jima, Ryukyu Islands in the North Pacific. In order to evaluate the utility of sclerosponge as an environmental proxy, within-skeleton and intraspecific variations in stable isotopic and trace elemental records of 37 samples were investigated. Soft X-ray images of large-size sclerosponges showed highly developed skeletal growth bands with >100 high/low density layers. The secular changes in radiocarbon-dated time series of the sclerosponge carbon records were consistent with previously reported data from Atlantic and Pacific corals and sclerosponges. The long-term oxygen isotopic trends of the samples are characterized by slight depletions throughout their living periods, indicative of an overall trend toward warmer ocean environment around the Ryukyu Islands. Our sclerosponge-based estimates of sea surface temperature and salinity may document thermal and hydrologic variations in the Ryukyu Islands, furthering a better understanding of northwestern tropical-subtropical Pacific climate change for the last several centuries in conjunction with coral-based long proxy records.

Keywords: sclerosponge, oxygen isotope, carbon isotope, trace element, paleoceanogrpahy, Okinawa

