Abstract

Skeletal banding of scleractinian corals offers an excellent archive of palaeoclimates owing to their ability to incorporate minor and trace elements, as well as stable isotopes into their aragonitic skeleton in relation to seawater parameters. These seamlessly perfect records are universally witnessed to randomise at the final growth band, where the living tissues directly contact the underlying skeleton. Understanding the transition from environment dependent signals in the deeper skeleton to environment independent at the skeletal surface is of critical importance for linking modern instrumental data with the paleo-archive recorded by corals. This undocumented anomaly may also have implications in our ability to capture modern, rapid warming events attributed to global climate change. Here, we not only introduce the first study whereby this geochemical anomaly is characterised through following skeleton geochemical response to external temperature modifications, but we also present the first study that uses experimental taphonomy to document and determine the effects of soft tissue decay on skeletal geochemistry.

Firstly, *Porites* micro-fragments were decayed in individual (semi-sealed) vials in oxic conditions for 72hrs. Within 12 hours, decay was evident through 1) non-uniform zooxanthellae expulsion, 2) the formation of nubilous, semi-spherical biofluid over (some) actinopharynxes and 3) highly uniform, white, needle-like precipitates believed to originate from the extracellular calcifying medium (ECM). After 72 hours, a biofilm had completely blanketed the micro-fragment. Oxygen and pH microsensors, deployed directly above the decay surface, recorded steady depletion in pH and oxygen saturation throughout the decay period. External microbes are believed to have entered the gastrovascular cavity through bacteria enriched surfaces of the intruded polyp, decaying the internal structures quicker than the external epidermal tissues.

Secondly, LA-ICP-MS analysis performed on a (non-decayed) microfragment was used to document elemental distributions in response to simulated temperature changes over a 6-month period. Our results show that the outer skeletal anomaly is not uniform for each element. However, the transition from unorganised to organised values is similar spatially and temporally for each element (500-600 µm / 20 days). Sr trends imply that vital effects, likely triggered from biological stress during coral collection, masked the original Sr signal leading to inconclusive SST reconstructions. Despite this, our ±0.5°C temperature simulations were observed through minor (non-sustained) Sr spikes. Thus, ±0.5°C variations are below the threshold to continue the new temperature signal. Mg records display strong metabolic influence (night and day calcification) making it challenging to isolate the temperature influence against metabolism.

Lastly, SIMS and microprobe analyses were performed on a (decayed) subsample of a *Porites* micro-fragment. Although we witnessed a clear deviation from deeper skeletal trends at the skeletal edge, the isolated effect of decay on $\delta^{18}O$ is not apparent. As the experimental setup remained stable, any slight variations in $\delta^{18}O$ are attributed to growth/calcification rates, directly related to diurnal cycles of light and dark calcification/fractionation mechanisms. The correspondence between elemental data from LA-ICP-MS analysis and isotopic data from SIMS analysis suggests that the difference between values of the outer skeletal edge and that of the deeper skeleton is related to skeletal growth phases involving complex partitioning of elements and isotopes in the ECM during skeletal uplift every 20-30 days. Questionably, the anomaly may be partially attributed to unattached needle-like (induced) precipitates contained in the ECM. When released through decay, there is no anomaly observed in the outer skeleton.

Keywords: Coral; geochemical anomaly; experimental taphonomy; SIMS, oxygen isotopes analyses; LA-ICP-MS analyses; microprobe analyses; diurnal cycle; kinetic effects; decay effects.