Calcium and alkalinity decoupling in a coral reef lagoon driven by submarine groundwater discharge

Isaac R. Santos[1*]; Douglas Tait[1]; Dirk Erler[1], Angela Dial[2], Kevin Befus[3], Bayani Cardenas[3], Ling Li[4]

[1]National Marine Science Centre, Southern Cross University, Coffs Harbour, Australia. *isaac.santos@scu.edu.au
[2]Magnetic Field Laboratory, Florida State University, Tallahassee, FL, USA
[3] Jackson School of Geosciences, The University of Texas at Austin, TX, USA
[4]School of Civil Engineering, The University of Queensland, Brisbane, QLD, Australia

While much of the submarine groundwater discharge (SGD) literature has focused on nutrients, SGD may also influence the carbon cycle and be a source of alkaline earth metals to the oceans. For example, the present-day calcium accumulation in marine sediments is 1.5 times greater than the sum of the known calcium influxes from rivers and mid-ocean ridges. Therefore, in order for the oceans to maintain a steady state in the calcium budget, an unaccounted for source of calcium must exist. Here, we use radium isotopes to estimate SGD into a coral reef lagoon surrounding a volcanic island in the Pacific Ocean. We also discuss the behaviour of dissolved calcium, magnesium, strontium and barium in the carbonate sand subterranean estuary. While calcium, strontium and magnesium behaved conservatively in the subterranean estuary, an alkalinity source was observed in shallow saline groundwaters. In addition, alkalinity was extremely enriched in fresh groundwater averaging 6.5 mM (about 3-fold higher than the local coral reef lagoon). The alkalinity source was likely related to sulphate reduction in anoxic sediments as supported by observed sulphide enrichments. The contrasting behaviour of dissolved calcium and alkalinity cycling in the subterranean estuary resulted in a decoupled cycle in nearshore surface waters influenced by SGD even though corals are expected to create a coupled cycle due to calcification.