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Boron Isotopes and Trace Element Constraints on Coral Responses to Elevated Alkalinity and Temperature.

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Ocean Alkalinity Enhancement is being explored as a carbon dioxide removal strategy that increases seawater alkalinity and promotes atmospheric CO_2 uptake as dissolved bicarbonate. Although this approach may mitigate ocean acidification, its consequences for coral reef ecosystems remain insufficiently constrained. In particular, the extent to which elevated alkalinity, independently and in combination with thermal stress, alters the internal calcification environment of reef-building corals is not well understood.

In this study, we examine the physiological and geochemical responses of tropical corals from the genera *Acropora*, *Pocillopora*, and *Stylophora* cultured for 6 to 8 weeks under experimentally elevated temperature and alkalinity conditions. In addition to measurements of photosynthesis, respiration, and bulk calcification rates, we analyse skeletal boron isotopes and trace element ratios to characterise changes in calcifying fluid chemistry and underlying biomineralisation processes.

Skeletal $\delta^{11}B$ was purified using a batch processing method prior to isotopic determination. Given the pH dependence of boron isotope fractionation in seawater, coral $\delta^{11}B$ serves as a quantitative proxy for calcifying fluid pH. This approach allows evaluation of whether alkalinity enhancement modifies the magnitude of internal pH upregulation and whether elevated temperature influences this regulatory capacity. Trace element ratios, including B/Ca, Sr/Ca, Mg/Ca, and U/Ca, are used to assess shifts in carbonate system parameters within the calcifying space and to identify potential modifications in ion transport mechanisms or crystal growth kinetics.

Preliminary physiological observations indicate substantial direct effects of elevated alkalinity on bulk calcification rates, but minimal alteration of photosynthetic or respiratory rates under combined warming and alkalinity treatments. The accompanying geochemical data provide an independent constraint on whether these metabolic responses are associated with measurable changes in calcifying fluid chemistry. By integrating boron isotope systematics with trace element behaviour, we evaluate whether Ocean Alkalinity Enhancement alters internal carbonate chemistry in a manner that could stimulate light-enhanced calcification at the reef scale.

This work delivers a mechanistic evaluation of the interactive effects of alkalinity enhancement and warming on coral biomineralisation, with implications for the efficiency of carbon sequestration strategies and for the reliability of coral-derived paleo-pH reconstructions under modified seawater chemistry.